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Subjective Stock Option Values and Exercise Decisions: Determinants and Consistency

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Abstract

Stock option programs constitute an important economic domain both for the issuing companies and for their employees. Little is known, however, about which individual variables actually drive exercise patterns and how employees value their stock options. We study the following set of research questions to provide a contribution to a better understanding of these topics: How do employees exercise and value stock options? What are the determinants of exercise decisions and subjective option values? Do employees exercise options from different grants in a consistent way? Are subjective option values consistent with individuals' exercise decisions? We are able to use a unique data set combining employee-level option exercises with subjective option values extracted by means of an internal survey. Furthermore, we can combine this data with a wide set of individual variables. We find that employees exercise their stock options well before expiration. The median individual sacrifices more than 90% of the option's lifetime by exercising early. Surprisingly, we also find that individuals substantially overvalue the options they received. We show that exercise dates and option values are unrelated with measures of risk aversion. Loss aversion, however, does a better job in explaining the heterogeneity in option values. We also document that optimism and overconfidence measures are significantly related to option values. We show that managers that are very optimistic about company stock place higher values on their options. This finding is consistent with the sentiment hypothesis presented in Oyer and Schaefer (2004) and Bergman and Jenter (2004). Some evidence for an intertemporal consistency of exercises decisions is also provided. However, we find only weak support for the hypothesis that higher option values are associated with later exercise decisions.

Keywords: Employee Stock Options, Exercise Behavior, Subjective Option Values, Correlation of Economic and Psychological Variables, Stock Option Accounting

JEL Classification Code: M41, M52, M55

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1 Introduction and Motivation

Recent academic research has provided many theoretical and empirical insights on compensation with employee stock options (ESOs). Researcher investigated issues like the reasons for the use of stock options, the effects of ESOs on firm performance, the economic costs of options, or the question of whether or not stock options provide opportunities for manipulations and the use of insider information.[1]

Despite current progress in the understanding of how stock options work, only little is known about the variables that actually drive individual-level exercise decisions. Moreover, it is still relatively unexplored how employees subjectively value the stock options they received. Core et al. (2003) therefore conclude in their survey on equity-based compensation that "an interesting question for future research is to examine how executives actually value their stock options."[2] This lack of empirical research is merely due to widespread data limitations in the field of ESO plans. To get a deeper understanding of the outlined issues, employee-level data on exercise transactions, subjective option values, and individual characteristics (like risk aversion, stockholdings or loss aversion) is crucial. However, companies usually hesitate to provide detailed data on their employees' stock option exercises. Moreover, they are generally very reluctant in allowing researchers to contact their employees in order to ask them questions about their subjective option valuations and individual traits.

This lack of data is unfortunate as studying exercise decisions and subjective option valuations of employees in ESO programs is very important as the following paragraphs will show.

The accounting costs of stock option programs crucially depend on how employees value and exercise their options.[3] Existing accounting rules allow firms to adjust the time parameter used in estimating the costs of stock options to account for early exercise decisions. Firms can use, for example, modified valuation models that include the expected time

[1] Reviews covering these topics are provided by Murphy (1999), Core et al. (2003) or Sautner (2005).

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

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

until options are exercised instead of the original time to maturity as an input parameter (see, e.g., Hull and White, 2004). Not taking into account early exercises would imply adverse effects on firms' reported earnings as it results in an overestimation of the ESO programs' accounting costs.[4] A precise estimation of the expected life of ESOs hence requires an understanding of how employees actually value and exercise their options, and to what extend these values/exercises vary with individual characteristics (and hence differ within an organization).

Economic models on stock option compensation assume that individuals understand how the incentive effects of stock options work and how the value of option packages is determined. But if option holders do not understand the basics behind stock option plans, e.g. if they systematically misprice options, then it is likely that the intended incentive effects of stock options do not work efficiently either (see Core et al., 2003)

Heterogeneous and possibly incorrect option valuations further matter for the general efficiency of stock options as a compensation device. If some individuals heavily discount option values while others value them highly, then efficient contracting suggests that individuals with low option valuations should rather be remunerated with other compensation forms that produce lower costs for the issuing firm (see Massey, 2003b). To assess the efficiency of option compensation, an estimate of individuals' subjective option values is therefore needed.

Only little empirical research explicitly links exercise decisions and subjective option values with psychological biases.[5] This is particularly unfortunate as some recent compensation models combine psychological biases and option compensation: The models by Bergman and Jenter (2004) as well as Oyer and Schaefer (2005) connect excessive employee optimism with option compensation using a sentiment story. They predict that employees generally do not value their options as suggested by existing valuation models and argue that firms grant stock options when their boundedly rational employees are overoptimistic. Empirical research on whether optimism really affects the subjective valuation of options is, however, far from mature and survey-based research is needed to

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

[5]See Heath et al. (1999) or Massey (2003b) for exceptions.

understand managers' expectations.

Having hinted why we think it is important to study individual-level exercise decisions, option values and their respective determinants, we can now formulate the research questions that we want to address empirically:

- How do employees exercise and value their stock options?
- What are the rational and psychological determinants of exercise decisions and subjective option values?
- Do individuals exercise options from different grants in a consistent way?
- Are subjective option values consistent with individuals' exercise decisions?

We believe that combining data on option exercises with survey data is a very effective way to address these research questions as it bypasses some of the main problems the existing ESO literature faces.[6] We are able to link detailed and individual-specific data on exercise transaction form managers working for a large German DAX company with survey data on ESO values. We can further combine this data with a large set of personal characteristics.

Our main findings can be summarized as follows. Employees in our data set exercise their options well before expiration and hereby sacrifice a significant proportion of the fair option values. If individuals are directly asked about how they subjectively value a specific stock option, they surprisingly state values that are substantially above the fair option value: employees assign a mean value of 31.21 Euro to an option with a fair value of about 26 Euro. We find that exercise decisions and option values are unrelated with measures of risk aversion. However, we find that employees with a highly firm-specific human capital discount their options more heavily. We provide evidence suggesting that more wealthy managers exercise later as they have more funds to diversify. Overall, our results indicate that psychological rather than rational variables are associated with ESO

[6] Existing research on option exercises regularly assumes certain parameter values, e.g. for risk aversion, to study exercise patterns of individuals in ESO programs (see Bettis et al., 2005, Oyer and Schaefer, 2005 or Carpenter, 1998). As these parameter values show large variation across individuals, using fixed parameter values in calibration exercises is not unproblematic.

values. We find, for example, that optimism and overconfidence measures are significantly related to option values. Managers that are more optimistic about company stock and the stock market as a whole place higher values on their ESOs. This finding is consistent with the sentiment hypothesis presented by Oyer and Schaefer (2004) and Bergman and Jenter (2004). Moreover, we find that more overconfident employees put a lower value on their options which is in line with the findings in Sautner and Weber (2005). We can further show that loss aversion does a better job than risk aversion in explaining the heterogeneity in option values. We also provide some evidence for the intertemporal consistency of option exercises: employees that exercised early in one grant also did so in an other one. However, our findings offer only weak support for the hypothesis that higher option values are generally associated with later exercise decisions.

The remainder of this paper is organized as follows: Section 2 discusses related empirical research that studies exercise decisions in ESO programs and the values employees place on their stock options. The data sets, the company, institutional details of the stock option grants, and the methodology are presented in Section 3. Section 4 contains descriptive results on exercise patterns and subjective option values. If further defines the variables gathered by our questionnaire and presents summary statistics on individual characteristics. Section 5 studies the determinants of individuals' exercise decisions and their option values. Moreover, it investigates whether exercise decisions and elicited option values are consistent with each other. Finally, Section 6 summarizes our results and concludes.

2 Related Literature

2.1 Empirical Research on Stock Option Exercise Decisions

This subsection surveys the empirical literature that studies exercise decisions of individuals in ESO programs. The subsequent subsection will then look at research that explicitly analyzes how individuals subjectively value stock options they received. Based on this brief literature review, we will show how our study extends the existing body of research on option exercises and values.

We already noted that data on employee behavior in ESO plans is highly confidential and

causes a lack of empirical studies in the field.[7] Core and Guay (2001) study aggregated exercise decisions of non-executives in more than 700 U.S. firms. Among other things, they document that option exercises are greater when the realizable value of a stock option on exercise captures a greater percentage of the theoretical Black and Scholes (1973) value.

Bettis et al. (2005) investigate how cross-sectional firm characteristics and management positions affect option exercises. They use information on employees' levels in firms as a proxy to capture the effects of unobserved variables like risk aversion or wealth.[8] Bettis et al. find that individuals working for companies with the largest stock price volatility exercise their ESOs earlier compared to those working for firms with the lowest volatility. Moreover, they document that individuals at higher levels hold their ESOs significantly longer than those at lower ones. This finding is considered evidence consistent with risk averse individuals that exercise to reduce the exposure to firm specific risk.

The question of how psychological factors influence exercise decisions was first studied by Heath et al. (1999) and Huddart and Lang (1996). They show that option exercises take place well before expiration. The maximum permissible number of options has been exercised by many employees shortly after the first vesting anniversary. The major contribution of the their studies, however, is that they predict and find that exercise decisions and psychological variables are related. They hereby document two psychological biases. The first one reflects employees' beliefs that short-term price trends will reverse and that long-term price trends will persist. The second bias relates to the tendency of individuals to set reference points. Based on psychological research, 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 the maximum price level set at some point of time during the preceding year.[9]

Massey (2003a) matches detailed data on exercise decisions of employees working for a

[7] The scarcity of publicly available data is even more pronounced for *broad-based* option programs as U.S. firms need to publish information only on option exercises by top executives, but not on those by lower-level employees. The behavior of individuals trading in *exchange-traded* stock options is studied by Poteshman and Serbin (2003).

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

[9] Core and Guay (2001) confirm these biases using their much broader sample.

Fortune 100 company with a set of demographic characteristics. He studies the decision of whether or not to exercise ESOs from a given option grant during a specific week and hereby finds that exercise decisions are sensitive to behavioral factors (the short-term stock performance), the volatility of the option, the time-to-maturity, and to an individual's experience with ESOs. However, demographic characteristics and exercise activity seem to be unrelated in his study.

Detailed exercise data from a large German company was analyzed by Sautner and Weber (2005). They link exercise decisions with survey data on individuals' characteristics, attitudes, and expectations. Among other things, they find that, inconsistent with traditional ESO theories, exercise behavior is not driven by risk aversion and holdings of company stock. Their findings, however, suggest that exercise decisions depend on the psychological factors overconfidence and mental accounting.

2.2 Empirical Research on Subjective Stock Option Values

Only few empirical studies investigate how individual employees value the stock options they are holding. This is mainly due to the prevalent reservation of most firms with respect to questionnaires on their own ESO plans. Existing studies therefore try to circumvent this problem by surveying students or newsletter readers with questions on non-existing virtual stock options.

Lambert and Larcker (2001), for example, base their study on a survey of 122 knowledge@wharton readers. They asked these people how much their employing companies would have to offer them to return a fully vested but imaginary stock option (they hence asked for individuals' certainty equivalents). Their results show that individuals substantially overvalue options relative to the theoretical Black and Scholes (1973) value. Young employees at low management grades show the highest upward bias in option values. Lambert and Larcker further document that higher expectations for future stock prices are correlated with higher option values.

The research by Hodge et al. (2005) is based on a survey conducted with university students. In line with Lambert and Larcker, they asked their subjects how much money they would require to exchange an imaginary stock option. They also provide evidence

suggesting that individuals value ESOs substantially above the Black and Scholes value.

Massey (2003b) studies determinants of subjective option values for a real option program of a Fortune 100 firm. He finds that risk aversion and stock price expectations are significantly related to option values: more risk averse and less optimistic employees place lower values on their ESOs. Moreover, he documents that loss aversion and mental accounting are negatively correlated with individuals' option values, indicating that psychological considerations also affect subjective ESO valuations.

Our study extends the existing body of literature by linking both subjective option values and individual-level exercise data. To perform this task, we can use data on three existing real stock option grants of a German DAX company. Moreover, we can employ survey data to investigate how a wide set of individual characteristics affects option values and exercise decisions. Overall, our resulting data set enable us to address questions that have not yet been studied in the academic literature.[10]

3 The Data Sets, the Company, and the Stock Option Programs

3.1 The Data Sets and the Company

This subsection describes the two data sources we use. It further contains information about the company that was providing the stock option data.

The first data set contains individual-level stock option exercise transactions of 182 senior employees. The data set includes detailed individual-level records of all option exercises that were executed in two distinct stock option grants (denoted by g=1 and g=2) between May 2002 and July 2004. The data set further contains information on the grade levels of the individuals, and on how many options they were granted in the two option series.

The second data set consists of comprehensive data on employee-specific characteristics like risk aversion, tenure or stock price expectations, and was collected by means of a questionnaire. The survey data further includes individual-level certainty equivalents for

[10] At least not to our knowledge.

the value of a real stock option of a third ESO grant (labelled g=3): we directly asked each employee on the value he subjectively puts on an unvested option of this third option series. Our questionnaire was directed to all 182 managers that were included in the first data set. We received a total of 62 responses yielding in a response rate of 34.07%.[11] The survey was conducted in March/April 2005 (with one reminder). To avoid strategic and untruthful answering, we assured that survey responses are treated confidentially. In particular, we guaranteed that neither the executive board nor the human resources department of the firm will be able to access individual survey responses.

The individuals in our data sets belong to the second (n = 19), third (n = 51) and fourth (n = 112) management level of the firm.[12] Seven managers of the second, 20 of the third, and 35 of the fourth level returned the questionnaire. All employees worked for the German core unit of the corporation (the so-called Aktiengesellschaft). To make sure that our results are not based on exercise patterns that are observable only at the level of the Aktiengesellschaft, we compared exercise patterns in the German unit with aggregate exercises for the entire company (the Group).[13]

The company that provided the option data is a member of the German large-cap index DAX. It is one of the largest in its industry worldwide and employs more than 80,000 people. Extraordinary company-specific events like bankruptcy or financial distress that might have significantly influenced our results occurred neither during the vesting nor during the exercise periods of the three option grants.

3.2 The Stock Option Program

This subsection provides institutional details on the stock option program we investigate. Options of the first grant (g=1) were issued in 1999, and the exercise period within which options are exercisable ranged between May 2002 and May 2005. The options of the second grant (g=2) were issued in 2000, and the exercise period is from May 2003 to May 2006.

[11] Which is a reasonable number for this kind of survey-based research.

[12] The company did not provide data on exercises by board members.

[13] See below for details. The Group includes approximately 800 additional employees that are mainly employed outside Germany (e.g. in the U.S.).

Options of the third grant (g=3) were issued in March 2003 and were not yet exercisable when we received the ESO data. The vesting period of the latter options ended in May 2005, and the subsequent exercise period runs until June 2011. Options of all three grants can only be exercised if at least one out of two performance conditions is met. The first condition requires that the stock price rises by 30%, given the stock price at the grant date (absolute performance condition), while the second condition requires that the company outperforms an industry basket (relative performance condition).

The exercise gain of an option of a certain grant g=i, with $i \in \{1, 2, 3\}$, also consists of an absolute and a relative component. Given that the absolute performance condition is met, the absolute exercise gain $G_{absol.}^{g=i}$ is calculated as $G_{absol.}^{g=i} = (S_t - X)$, with X being the stock price at the grant date and S_t the company's stock price at date t. If the relative performance condition is achieved, the relative exercise gain $G_{rel.}^{g=i}$ is computed as $G_{rel.}^{g=i} = 2 \cdot (P_{comp.} - P_{ind.}) \cdot X$, with $P_{comp.}$ and $P_{ind.}$ being the company and industry performance, respectively (each in %). The total exercise gain, conditioning on both conditions being met, is therefore $G_{total}^{g=i} = G_{absol.}^{g=i} + G_{rel.}^{g=i}$. By May 2005, the exercise gains of the three option grants were as follows: $G_{absol.}^{g=1} = 0$, $G_{rel.}^{g=1} > 0$, $G_{absol.}^{g=2} = 0$, $G_{rel.}^{g=2} > 0$, $G_{absol.}^{g=3} > 0$ and $G_{rel.}^{g=3} = 0$.

All employees received stock options if and only if they fulfilled a required stock investment (RSI). They therefore had to introduce a specific number of company shares into the option program.[14] An individual then received four options for each share of company stock he introduced into the program. To avoid insider conflicts, the company designed four closed periods per year within which options are not exercisable at all. Closed periods were set around calendar dates were quarterly or annual earnings are published. Each closed period encompasses two to six weeks. The accounting costs of the stock option grants were fully expensed by the company.

[14] An individual can invest between 10 and 30% of his annual bonus into shares of company stock. These shares are then introduced into the ESO program. Individuals are prohibited form disposing over the shares of this required stock investment (RSI) during the entire vesting period.

3.3 The Methodology

To reduce potential problems resulting from misinterpretations of the survey questions, we conducted a pilot survey to incorporate feedback by the company and its employees. We decided to employ survey methodology because of the following reasons. Extant economic theory makes predictions about the variables that are supposed to affect subjective option values and individual exercise decisions (see Lambert et al., 1991 or Hall and Murphy, 2000, 2002). However, these variables are usually not observable. Existing research on option exercises therefore regularly assumes certain parameter values, e.g. for risk aversion, to study exercise patterns of individuals in ESO programs (see Bettis et al., 2005, Oyer and Schaefer, 2005 or Carpenter, 1998). But these parameters show large variation across individuals and using fixed parameter values in calibration exercises is consequently not unproblematic. A questionnaire has the potential to bypass these problems by directly asking individuals about their personal characteristics (see Hodge et al., 2005). The same kind of reasoning applies to subjective option values. These values are individual-specific by nature and can not be extracted from market prices as options are usually not traded. To answer the question of how managers value their stock options, one therefore needs to ascertain option values by directly contacting individual employees.[15]

We are aware that studies using survey data have several shortcomings. Examples are potential non-responses biases, differences in the interpretations of questions, or the problem of not measuring actions but beliefs.[16] However, we think that combining transaction data with survey data is a promising way to get a better understanding of individual-level exercise decisions and subjective option valuations. In particular, we think that the possibility to ask senior employees on how they personally value a fully-fledged real stock option provides an exciting basis to address our outlined research questions and outweighs potential survey shortcomings.

[15] See Ikäheimo et al. (2004) for an exception.

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

4 Exercise Decisions and Subjective Option Values: Descriptive Results

4.1 Descriptive Statistics on Stock Option Grants and Exercise Patterns

Before discussing the determinants and consistency of exercise decisions and option values, we summarize aggregate results on the stock option grants and exercise patterns in our data set. These statistics are useful to get a deeper understanding of the grants that were made and about the aggregate exercise activity.

Descriptive statistics on the ESO grants and exercises are documented in Table 1. Summary statistics include the number of options issued in the first (g=1) and second (g=2) grant, the number of exercises per individual, the realized per-option exercise gains (in Euro), the overall exercise gains (in Euro), the fraction of the respective option life that was sacrificed at the date of exercise, and information about the required stock investments. The table contains means, medians, minimums, maximums and standard deviations of all variables. *Option Life Sacrificed*, our measure of early exercise, is defined as follows (see Bettis et al., 2003):

$$\textit{Option Life Sacrificed} = \frac{\textit{Number of days the option was exercised prior to expiration}}{\textit{Number of days between vesting and expiration}} \tag{1}$$

If individuals exercised their options at more than one date, weighted averages of the sacrificed option lifetimes were calculated. The resulting variable ranges between 0 and 1, with higher values indicating that an individual sacrificed a greater proportion of the option's life by exercising before maturity. The sample size consists of 182 employees. To construct the summary statistics for the exercise gains and for *Option Life Sacrificed*, we used exercise data only of those employees that have entirely exercised their options (154 individuals in the first and 140 in the second grant).

The table shows that the average manager received 1,116 stock options in first and 1,005 options in the second grant. The figures show substantial differences within the firm, with granted options ranging from only 72 up to 4,904 in g=1 and from 84 up to 4,676 in g=2.

Table 1: **Summary Statistics on Stock Option Grants and Exercise Patterns**

This table provides descriptive statistics on option grants and exercise patterns. Summary statistics include the number of options issued in the first (g=1) and second (g=2) option grant, the number of exercises per individual, the total per-option exercise gain that was realized (in Euro), the overall exercise gain (in Euro), the fraction of the option life that was sacrificed at the time of exercise, and the percentage of the annual bonus that was invested within the required stock investment. If individuals exercised options at more than one date, weighted averages were calculated. The table contains means, medians, minimums, maximums, and standard deviations of all variables. *Option Life Sacrificed* is defined as the ratio of the number of days the option was exercised prior to expiration divided by the number of days between vesting and expiration. Days of the closed periods were excluded when we calculated this measure of early exercise. The sample size consists of 182 employees. To calculate the exercise gains and *Option Life Sacrificed*, we only used data of those employees that have exercised their options entirely (154 for the first and 140 for the second grant). The options of the first (second) grant were issued in 1999 (2000) and the exercise period ranges between 05/2002 and 05/2005 (05/2003 and 05/2006).

Variable	**Mean**	**Median**	**Min.**	**Max.**	**Std.dev.**
Options granted in g=1 (per person)	1,116	980	72	4,904	882
Options exercised in g=1 (per person)	987	865	0	4,904	906
Options granted in g=2 (per person)	1,005	852	84	4,676	827
Options exercised in g=2 (per person)	849	704	0	4,676	403
Number of exercises in g=1 (per person)	1.33	1.00	0.00	11.00	1.13
Number of exercises in g=2 (per person)	1.08	1.00	0.00	4.00	0.67
Exercise gain per option in g=1 (per person)	26.85	27.54	20.16	33.79	4.06
Exercise gain per option in g=2 (per person)	36.81	37.45	28.18	41.99	2.50
Overall exercise gain in g=1 (per person)	29,481	23,970	2,383	153,546	24,749
Overall exercise gain in g=2 (per person)	38,025	31,447	3,169	176,425	30,594
Option Life Sacrificed in g=1	0.85	0.91	0.26	1.00	0.18
Option Life Sacrificed in g=2	0.92	0.98	0.59	1.00	0.11
Required Stock Investment in g=1 (in %)	22.94	30.00	10.00	30.00	8.38
Required Stock Investment in g=2 (in %)	21.98	25.00	10.00	30.00	8.68

By July 2004, about 88% of the options of the first and roughly 84% of the options of the second grant were already exercised.[17] This reflects the general propensity of many employees to exercise their stock options very early.[18] The median employee exercised its options in one large transactions, but some individuals have spread their options over several exercises. The mean per-option exercise gain in the first grant was equal to 26.85 Euro. Depending on the exact date of the exercise decisions, realized gains fluctuate heavily between 20.16 and 33.79 Euro. For the second grant, the mean exercise gains was 36.81 Euro and the per-option profit varies between 28.18 and 41.99 Euro. The median employees realized an overall exercise gain of 23,970 Euro in the first and 31,447 Euro in the second ESO grant (which is certainly a significant proportion of the average salary). The mean value of the variable *Option Life Sacrificed* is 0.85 (0.92) for the first (second) grant, indicating that the average employee sacrificed 85% (92%) of the option's total life by exercising pre-maturely. In the first grant, individuals on average invested 22.94% of their annual boni into shares of company stock for the RSI (21.98% in the second grant).[19] Recall that individuals could invest between 10 and 30% of their annual boni into shares for the RSI.

Figure 1 and Figure 2 present cumulative option exercises over time as a percentage of options granted in g=1 and g=2 (Figures are provided in the Appendix). The time dimension reflects the days after vesting from the viewpoint of the first ESO grant onwards.[20] Figure 1 plots the cumulative distribution for the German core unit of the firm (Aktiengesellschaft), while Figure 2 shows the distribution for the entire company (Group). Recalling that both grants had an exercise period of roughly three years, these figures reinforce the conclusion that individuals have a strong tendency to exercise early. A comparison of Figure 1 and Figure 2 indicates that the managers of the Aktiengesellschaft generally have a stronger propensity to exercise early compared to those of the rest of the corporation.

A distribution of the *Option Life Sacrificed* variables is presented in Figure 3 (for g=1)

[17] We received data on exercises executed up to July 2004.

[18] This finding is consistent with related research (see Huddart and Lang, 1996, Heath et al., 1999, Bettis et al., 2005 or Sautner and Weber, 2005).

[19] This variable was available for 177 individuals only.

[20] The days of the closed periods were excluded when we calculated the time dimension in these figures.

and Figure 4 (for g=2).[21] For both distributions, the mode of the variable is immediately after the vesting date. However, the figures show that a significant exercise activity also occurred during the lives of the the two option grants (reflecting some heterogeneity across individuals).

Having observed that many employees tend to exercise relatively early, the question arises whether early exercises were driven by superior private information. We therefore linked sacrificed option lives and realized exercise profits to investigate whether the data supports a private information story. Interestingly, Figure 5 and Figure 6 show that late exercisers made a higher exercise profit on average. A correlation analysis also yields a highly significant negative correlation coefficient for the first and for the second ESO grant[22], and a simple linear regression model likewise estimates a coefficient of *Option Life Sacrificed* equal to -14.12 for the first and -14.21 for the second grant.[23] In summary, these results support the view that early exercisers did not exploit private information profitably.

Finally, Figure 7 presents the relationship between *Option Life Sacrificed* and the captured fair option value at the date of exercise (for g=1).[24] A low value of the latter variable indicates that an individual sacrificed a large fraction of the option's expected value by exercising. The mean (median) value for this variable is equal to 0.8054 (0.7986), implying that employees sacrificed about 20% of the option's fair value when they exercised. This figure is again consistent with the results documented in related research (see Huddart and Lang, 1996 or Bettis et al., 2005). A correlation analysis between *Option Life Sacrificed* and the captured fair value yields a significant correlation coefficient of Rho = -0.2992 (p-value = 0.0295; n = 53), and a linear regression estimates a coefficient of *Option Life Sacrificed* equal to -0.3486 (p-value = 0.000, n = 54, R^2 = 0.4359, intercept = 1.1096). These results show that early exercisers on average forfeited more of the option's fair value.[25]

[21] The remaining analysis focuses on individuals working for the Aktiengesellschaft.

[22] Rho = -0.5945 (p-value = 0.0000, n = 152) and Rho = - 0.5675 (p-value = 0.0000, n = 139), respectively.

[23] With p-value = 0.000, n = 152, R^2 = 0.3491, and intercept = 38.87 in the first grant, and p-value = 0.000, n = 139, R^2 = 0.3421, and intercept = 49.92 in the second one.

[24] Due to the complexity of the option program, fair values were provided on a monthly basis only. They do, however, provide a good approximation of the fair values at the exercise dates.

[25] Similar results were found for the second grant (not reported here).

Table 2: **Subjective Option Values**

This table provides summary statistics of the subjective stock option values that were stated in the questionnaires (in Euro). We asked individuals for their certainty equivalents of an outstanding and unvested option of the third ESO grant (g=3). The options of this grant were issued in 2003, vest in 07/2005, and expire in 06/2011. The table presents the mean, the median, the minimum, the maximum, and the standard deviation of the elicited subjective option values. It further includes the number of observations that was available. The table also contains information on how many of the stated option values were below (above) the fair option value (in %). In March 2005, i.e. when most individuals filled in the questionnaire, the fair value of an option of this grant was equal to 26.13 Euro.

***Subjective Option Value* (in Euro)**			
Mean	31.21	Median	30.00
Min.	13.00	Max.	46.00
Std.dev.	8.81	Obs.	61
Stated Value $\leq$ Fair Value	37.70%	Stated Value $>$ Fair Value	62.30%

4.2 Descriptive Results on Subjective Option Values

Having studied aggregate exercise patterns, we now turn to the question of how employees in our data set subjectively value the options they received. Table 2 provides summary statistics of the subjective stock option values that were elicited by means of our questionnaire (in Euro). We asked individuals for the certainty equivalent of an outstanding and unvested option of the third ESO grant (g=3). Recall that the options of this grant were issued in 2003, vest in July 2005, and expire in June 2011. The table presents the mean, the median, the minimum, the maximum, and the standard deviation of these elicited option values. The table further contains information on how many of the stated option values were below and above the fair option value (in %). In March 2005, i.e. when most individuals filled in our questionnaire, the fair value of an option of this grant was equal to 26.13 Euro.

The table shows that individuals on average value their stock options substantially *above* the mathematically correct value. More specifically, individuals assign a mean (median)

value of 31.21 Euro (30.00 Euro) to an option with a fair value of 26.13 Euro. Roughly two-thirds of the option holders valued their ESOs above this value. The entire distribution of the stated option values is plotted in Figure 8. The numbers show that, even though we observe a strong tendency to overvalue options, there is again some heterogeneity within the organization. Some managers even seem to severely discount the value of their options. Overall, our finding is in line with related research that also documents this kind of overvaluation bias in survey studies (see Lambert and Larcker, 2001, Hodge et al., 2005 and Massey 2003b). Our evidence is highly inconsistent with economic theory that suggests that individuals should value employee stock options significantly *below* its fair value as they are inherently undiversified (see, e.g., Lambert et al., 1991 and Subsection 5.1).

4.3 Descriptive Statistics on Individual Characteristics

We now turn to the individual variables that were gathered by means of our questionnaire. These variables will later be linked with the exercise data and the ascertained option values. Table 3 summarizes and defines the variables that are used in the subsequent empirical analysis.

Risk Aversion 1 measures an employee's self-reported degree of risk aversion using the methodology employed in Klos and Weber (2003). Individuals had to divide a given amount of money, 1,000,000 Euro, between a risky lottery and a safe investment. The response range was between 0% (if everything was invested in the safe asset) and 100% (if everything was invested in the risky lottery). Clearly, the lower the proportion of wealth that is invested in the risky asset, the higher the degree of individual risk aversion. In the subsequent analysis, we classify answers below (equal to and above) the median response as high (low). *Risk Aversion 2* captures an employee's degree of risk aversion based on the certainty-equivalent method.[26] The lower the elicited certainty equivalent, the higher the degree of risk aversion. We again classify answers below (equal to and above) the median response as high (low). *Stockholdings* is the ratio of the value of an employee's company stockholdings to his total wealth (answers in %). Responses below (equal to and above)

[26] We elicited certainty equivalents based on a lottery that provides a 50% chance of winning an amount equal to 1,000,000 Euro and a 50% chance of winning nothing (see Klos and Weber, 2003).

the median response are classified as low (high). *Wealth* measures an employee's total wealth. We proxy wealth by the management grade of an employee in the corporation. We classify individuals at the second and third management level as high, and those at the fourth level as low. Following May (1995) and Degeorge et al. (2004), we use tenure as a proxy for the firm-specificity of human capital. *Firm-specificity of Human Capital* is measured by the number of years an employee works for the option granting company. We classify answers below (equal to and above) the median response as low (high).

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

An employee's degree of optimism about company stock is captured by *Optimism Company*. It is based on a forecasting question about the expected return for company stock over a five-year horizon (responses in %). We classify answers below (equal to and above) the median response as low (high). An employee's degree of overconfidence (also called miscalibration) with regard to company stock, *Overconfidence Company*, is measured based on a forecasting question about upper and lower bounds of the share price level of company stock over a five-year horizon. Following DeBondt (1998), we calculated the resulting confidence intervals as the difference between the high forecast and the low forecast, divided by the stock price level at the date of forecast and multiplied by 100. Answers below (equal to and above) the median response were classified as high (low). *Optimism Market* measures an employee's general degree of optimism and is based on a forecasting question about the expected return for the German stock market index DAX over a five-year horizon. We again classify answers below (equal to and above) the median response as low (high). *Overconfidence Market* reflects an employee's degree of overconfidence based on a forecasting question for upper and lower bounds of the index level of the German stock market index DAX (once more over a five-year horizon). Confidence intervals were again calculated using the methodology suggested by DeBondt (1998). We classify answers below (equal to and above) the median response as high (low).

Table 3: **Definition of Variables**

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

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

An employee's degree of wealth integration is captured by *Narrow Bracketing*. Employees responded on a five-point scale with the endpoints "1 = no wealth integration" and "5 = high level of wealth integration" on a question about their degree of narrow bracketing. Higher values hereby imply a lower degree of narrow bracketing. We classify answers below three (equal to and above) as high (low). We further measured how far employees look ahead with respect to stock price changes and option values (*Myopia*). Employees responded on a six-point scale with the endpoints "1 = less than a week" and "6 = more than two years". Answers below (above) two years are classified as high (low). *Frequency Supervision* finally measures how often an employee checks the exercise gains he can realize by exercising.[27] Employees responded on a seven-point scale with the endpoints "1 = several times a day" and "7 = less than once a month". We consider answers below (equal to and above) 5 as high (low).

Summary statistics on this set of individual characteristics are provided in Table 4. Apart from the variables defined above, the table also includes information on the fraction of total wealth invested in equity (*Ratio Equity*), and on the fraction of equity holdings invested in company stock (*Ratio Company Stock*). The table contains means, medians, minimums, maximums, and standard deviations of all variables. It further includes the number of observations of the respective variables (Obs.).

The average individual invested 35.35% in the risky lottery (*Risk Aversion 1*). The mean certainty equivalent for a 50% chance of winning 1,000,000 Euro and a 50% chance of winning nothing was 250,000 Euro (*Risk Aversion 2*). On average, employees in our sample invested 7.60% of their total wealth in company stock (median = 5.25%, std.dev. = 7.85%). As a fraction of his overall equity holdings, the average option holder has a considerable investment in company stock (41.61%). This figure displays that most employees in our data set are highly undiversified. Their investment strategies contrast the recommendations given by Markowitz (1952) and Sharpe (1964) who suggest that people should hold well-diversified portfolios.[28] Most people have been working for the company for a period of more than 20 years, which even deteriorates their diversification problems.

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

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

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

This table provides summary statistics on an extensive set of individual characteristics. Among other variables, it encompasses an individuals' degree of risk aversion, his stockholdings, his wealth, his firm-specificity of human capital, his optimism, and overconfidence. The variables are defined in Table 3. The table also includes information on the fraction of total wealth that is invested in equity (*Ratio Equity*). Moreover, it contains the percentage of equity holdings that is invested in company stock (*Ratio Company Stock*). The table contains means, medians, minimums, maximums, and standard deviations of all variables. It further includes the number of observations of the respective variables (Obs.). Summary statistics were calculated on the basis of 62 returned questionnaires (and on the basis of confidential information provided by the company (Wealth)).

Variable	**Mean**	**Median**	**Min.**	**Max.**	**Std.dev.**	**Obs.**
Risk Aversion 1 (in %)	35.35	30.00	0.00	100.00	28.65	62
Risk Aversion 2	250,000	250,000	50,000	650,000	164,751	57
Ratio Equity (in %)	20.16	15.00	5.00	65.00	12.11	62
Ratio Company Stock (in %)	41.61	30.00	5.00	95.00	28.40	62
Stockholdings (in %)	7.60	5.25	0.75	48.75	7.85	62
Wealth	3.51	4.00	2.00	4.00	0.68	182
Firm-specificity of Human Capital	22.87	24.00	13.00	35.00	5.36	62
Loss Aversion	3.36	4.00	2.00	4.00	0.80	55
Optimism Company (in %)	20.41	22.65	-28.90	60.00	20.33	54
Overconfidence Company (in %)	47.61	40.88	7.11	106.65	26.61	46
Optimism Market (in %)	20.87	20.00	-31.50	59.93	19.67	54
Overconfidence Market (in %)	51.38	45.70	11.42	159.93	32.66	47
Narrow Bracketing	2.42	2.00	1.00	5.00	1.37	60
Myopia	4.90	5.00	2.00	6.00	1.18	61
Frequency Supervision	5.08	5.00	2.00	7.00	1.56	61

Table 5: **Relationship between Measures of Risk Aversion and Loss Aversion**

This table presents pairwise correlations between *Risk Aversion 1*, *Risk Aversion 2*, and *Loss Aversion*. It further includes the significance level of each correlation coefficient (in parentheses) as well as the number of observations used in calculating the respective correlation coefficient. The variables are defined in Table 3. * indicates significance at 10%, ** indicates significance at 5%, *** indicates significance at 1%.

	Risk Aversion 1	*Risk Aversion 2*	*Loss Aversion*
Risk Aversion 1	1.0000		
	62		
Risk Aversion 2	0.5462***	1.0000	
	(0.0000)		
	57	57	
Loss Aversion	-0.3858***	-0.6880***	1.0000
	(0.0036)	(0.0000)	
	55	53	

The mean (median) value of tenure, our proxy for the *Firm-specificity of Human Capital*, is 22.78 years (24.00 years). Employees in our sample are very loss averse on average: the mean value of our categorial variable for loss aversion is equal to 3.36. The average individual predicted a company stock return of 20.41% over the five-year horizon, with responses varying heavily between -28.90% and 60% (*Optimism Company*). Expected returns for the market index DAX (*Optimism Market*) turned out to be of similar size, with a mean value of 20.87% and a minimum (maximum) of -31.50% (59.93%). The average confidence interval is 47.61% for company stock (*Overconfidence Company*) and 51.38% for the DAX (*Overconfidence Market*). Most managers suffer from *Narrow Bracketing* and do not integrate their financial wealth (median = 2.00, mean 2.42). The median option holder looks less than two years ahead with respect to stock price changes and option values (*Myopia*), and checks his potential exercise gains several times a month (*Frequency Supervision*).

Table 5 presents pairwise correlations between *Risk Aversion 1*, *Risk Aversion 2*, and *Loss Aversion*. It shows that our measures of risk aversion are consistent in the sense that higher risk aversion in the self-reporting treatment is significantly associated with higher

risk aversion in the lottery treatment (Rho = 0.5462, p-value = 0.0000). Furthermore, we find that a higher degree of risk aversion (according to both risk measures) is also associated with a higher degree of loss aversion.

5 Exercise Decisions and Subjective Option Values: Determinants and Consistency

5.1 Determinants of Exercise Decisions and Subjective Option Values

5.1.1 Theory and Predictions

This subsection derives testable predictions about the relationships between the individual variables presented above and sacrificed option lives/subjective option values. We therefore employ insights from economic theory and evidence from behavioral economics.

It is well-known that standard option pricing models are not appropriate for determining the value employees place on their stock options. Theoretical work has shown that risk aversion, diversification, and wealth need to be taken into account to explain subjective option values and the resulting exercise behavior of individuals in ESO plans. Option values and exercise decisions are linked as lower individual option values lead to earlier exercise decisions.[29]

The economic literature on individual behavior in ESO plans can be divided into two branches. Some studies explicitly model *subjective option values* as a function of risk aversion, diversification, and wealth, while other studies rather focus on the *optimal exercise decision*, i.e. the explicit date of exercise, as a function of these variables (often in a binomial set-up). Examples for the first branch of models are the studies by Lambert et al. (1991) and Hall and Murphy (2000, 2002) which show that options values are decreasing in risk aversion and company stockholdings but increasing in outside wealth. Examples for the second branch of models are papers by Huddart (1994) or Carpenter (1998). They demonstrate that more risk averse and less diversified individuals exercise stock options

[29] A stock option will generally be exercised whenever an employee's expected utility from exercising is greater than the expected utility form holding the option for another time period (see Huddart, 1994, Carpenter, 1998 or Bettis et al., 2005).

at earlier points in time.[30]

An important conclusion from both modelling approaches is that differences in individual characteristics can lead to significant heterogeneity in exercise decisions and option values within an organization.[31] Both approaches assume rationality on the part of the option holder and make predictions that are consistent with each other, i.e. they predict the same relationship between a certain variable and exercise decisions and subjective option values.

So far, economic models predict that risk aversion, diversification, and wealth generally affect exercises and option values. Sautner and Weber (2005) further argued that a higher firm-specificity of human capital can also have an impact on individual behavior in ESO plans. They reasoned that rational employees with a highly firm-specific human capital discount option values more heavily and exercise earlier to diversify.

Beyond the four rational variables considered above, psychological variables are likely to influence exercise decisions and subjective option values as well. Based on evidence in the behavioral economics literature, natural candidates for these psychological factors are loss aversion, optimism, overconfidence, narrow bracketing, myopia, and the frequency with which options are evaluated.

Massey (2003b) argues that greater loss aversion is associated with lower option values (and hence earlier exercises). Loss aversion causes employees to put more weight on potential losses than on potential gains.[32] As stock options can either appreciate or decrease in value relative to a certain reference point (e.g. relative to past exercise gains), more loss averse individuals will consider the lottery structure implied in options as less attractive and hence discount option values more heavily (resulting in earlier exercise decisions).

Exercise decisions and ESO values may also vary across employees because of differences in the individual level of optimism. Optimistic employees believe that future stock returns

[30] In these models, the optimal exercise policy is determined by using backward induction through the binomial tree starting at the expiration date.

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

[32] See Kahnemann and Tversky (1979).

are higher than they actually are. As subjective option values are increasing in the underlying stock price, overoptimistic employees place higher values on their stock options and exercise at later dates compared to less optimistic colleagues.[33]

If employees are overconfident, i.e. if they assign confidence intervals to their estimates of quantities that are too tight, this will have two effects on option values and exercises: on the one hand, it reduces value as the convexity of an option's payoff is underestimated, while on the other hand, it also increases value as the risk underlying options is misperceived (see Henderson, 2002).[34] Which of these two effects actually dominates and whether overconfidence overall has a positive or negative impact on option values and exercises is therefore an empirical question.

Our subsequent analysis further includes a variable that captures the extent by which employees suffer from narrow bracketing. Massey (2003b) uses prospect theory to argue that narrow bracketing affects option values and exercise activity. He claims that an individual that does not integrate his stock options into his total wealth will consider ESOs as less attractive and will therefore lower his subjective valuation of a given option package. Myopia is related to the concept of narrow bracketing as it can be considered as a form of narrow bracketing over time. Following the argumentation in Sautner and Weber (2005), we predict that individuals with very myopic perspectives concerning stock price changes will regard ESOs as less attractive and will therefore exercise at earlier dates. We further study whether the frequency by which an individual observes potential exercise gains on the firm's web page is also associated with his personal option values and his actual exercise decisions.

Having considered a set of rational and psychological variables that are supposed to affect subjective option values and exercise decisions, we can now formulate the hypothesis that we want to test empirically:

Hypothesis 1 (Determinants of Exercise Decisions and Option Values):

[33]Evidence suggesting that people regularly believe that more favorable events occur more often than they actually do can be found in Weinstein (1980) or Ito (1990). Sautner and Weber (2005) present evidence for overoptimism in stock option programs.

[34]For details and related literature showing that overconfidence is a strong phenomenon in finance, see Sautner and Weber (2005) or Glaser and Weber (2004).

Economic theory and psychological evidence predict that subjective option values and exercise policies significantly depend on risk aversion, stockholdings, wealth, firm-specificity of human capital, loss aversion, optimism, overconfidence, narrow bracketing, myopia, and the frequency by which potential exercise gains are supervised.

Table 6 summarizes the predicted relationships and reports whether the prediction is based on a rational model or on psychological evidence and reasoning. "+" means that a model or theory predicts an increase in the subjective option value and hence a later exercise decision with an increase in the respective variable. "-" likewise means that a model or theory predicts a decrease in the subjective option value and hence an earlier exercise decision with an increase in the variable. "?" means that no testable prediction is possible ex ante. Note that if the relationship is predicted to be positive, we expect the sign of the subjective option value to be *positive* but that of *Option Life Sacrificed* to be *negative* (as a higher option value means a later exercise decision and hence a lower number for the variable measuring the sacrificed option life).

5.1.2 Results

Having presented predicted relationships between various personal traits and exercise decisions/option values, we can now formally test whether these expected associations really hold in our data set.

Table 7 presents correlation coefficients (Spearman's Rho) between the individual-level characteristics and (i) *Option Life Sacrificed* for g=1, (ii) *Option Life Sacrificed* for g=2, and (iii) the subjective option values for g=3.[35] It further includes the significance level of each correlation as well as the number of observations used in calculating the respective correlation coefficient (Obs.). Note again that if the predicted relationship was positive, we expect the sign of the subjective option value to be *positive* but that of the variable *Option Life Sacrificed* to be *negative*.

The correlation analysis provides only little evidence supporting the rational option models presented in the previous subsection: both measures of risk aversion are unrelated with

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

Table 6: **Predicted Relationship between Stock Option Exercise, Subjective Stock Option Value, and Individual Characteristics**

This table reports predicted relationships between various rational and psychological variables and exercise decisions/subjective stock option values. "+" means that a model or theory predicts an increase in the subjective option valuation and hence a later exercise decision with an increase in the variable. "-" means that a model or theory predicts a decrease in the subjective option valuation and hence an earlier exercise decision with an increase in the variable. "?" means that no prediction is possible.

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

Table 7: **Correlation Coefficients (Spearman's Rho) between Option Lives Sacrificed, Subjective Option Values and Individual Characteristics**

This table presents correlations (Spearman's Rho) between (i) the sacrificed option life for g=1, (ii) the sacrificed option life for g=2, and (iii) the subjective option values for g=3 on the one hand, and an extensive set of individual-level characteristics on the other hand (rational and psychological variables). It further includes the significance level of each correlation coefficient as well as the number of observations used in calculating the correlation coefficient (Obs.). The variables are defined in Table 3. Note that if the relationship was predicted to be *positive*, we expect the sign of subjective option value to be *positive* but those of the sacrificed option lives to be *negative* (as a higher value means a later exercise decision and hence a *lower* number for the variable measuring the sacrificed option life). * indicates significance at 10%, ** indicates significance at 5%, *** indicates significance at 1%.

Variable	(i) **Option Life Sacrificed g=1**			(ii) **Option Life Sacrificed g=2**			(iii) **Subjective Option Value g=3**		
	Spearman's Rho	***p*-value**	**Obs.**	**Spearman's Rho**	***p*-value**	**Obs.**	**Spearman's Rho**	***p*-value**	**Obs.**
Rational Variables									
Risk Aversion 1	0.0449	0.7287	62	-0.0405	0.7545	62	0.1188	0.3616	61
Risk Aversion 2	0.0393	0.7717	57	-0.0805	0.5517	57	0.2059	0.1279	61
Stockholdings	-0.1631	0.2052	62	0.0205	0.8745	62	0.2550**	0.0473	61
Wealth	-0.1710**	0.0210	182	-0.2578***	0.0004	182	-0.0350	0.7891	61
Firm-specificity of Human Capital	0.1593	0.2163	62	0.0192	0.8820	62	-0.2938**	0.0215	61
Psychological Variables									
Loss Aversion	0.1365	0.3204	55	0.1629	0.2346	55	-0.2656*	0.0523	54
Optimism Company	-0.1406	0.3105	54	-0.1729	0.2112	54	0.3453**	0.0113	53
Overconfidence Company	-0.0294	0.8464	46	0.0461	0.7607	46	0.2993**	0.0458	45
Optimism Market	-0.1680	0.2247	54	-0.1928	0.1624	54	0.2730**	0.0480	53
Overconfidence Market	0.0057	0.9696	47	-0.0765	0.6095	47	0.2816*	0.0580	46
Narrow Bracketing	-0.1015	0.4405	60	0.0085	0.9485	60	0.1158	0.3826	59
Myopia	-0.2181	0.0912	61	-0.0613	0.6389	61	0.1413	0.2816	60
Frequency Supervision	0.1258	0.3340	61	0.0025	0.9850	61	-0.3340***	0.0091	60

the option lives that were sacrificed as well as with subjective option values. This finding is consistent with the results in Sautner and Weber (2005) who also find no association between risk aversion and exercise decisions using individual-level data. Higher holdings of company stock are surprisingly associated with higher option values which is inconsistent with our hypothesized direction.[36] As predicted, we find that option values are decreasing in the firm-specificity of human capital. The correlations between our proxy for wealth and both measures of early exercise are negative and significant, suggesting that individual with more outside wealth hold their options shorter.[37] Taken together, our results indicate that rational economic variables are only poorly related to exercise decisions and subjective option values.

Our findings, however, show that psychological factors are more heavily correlated with subjective option values (but surprisingly not with exercise decisions). Consistent with the prediction in Massey (2003b), we find that more loss averse individuals put lower values on their ESOs. Moreover, both optimism and overconfidence measures are significantly correlated with the option values elicited: more optimistic and less overconfident managers place higher values on their options compared to less optimistic and more overconfident managers. The coefficients for optimism have the anticipated signs and our results are consistent with the sentiment hypothesis presented in Oyer and Schaefer (2004) and Bergman and Jenter (2004). Their theories suggested that excessive optimism causes individuals to overvalue stock options. Furthermore, our overconfidence results are in line with the findings in Sautner and Weber (2005) and indicate that the overconfidence (measured as miscalibration) significantly affects option values.

Opposed to our prediction, we find no evidence suggesting that narrow bracketing and

[36] Surprisingly, we find that the RSI variable of both grants is neither significantly correlated with the stated option values nor with the sacrificed option lives. Regarding the determinants of the required stock investment, our data suggests that both RSI variables are significantly positively correlated with holdings of company stock. Moreover, they are significantly negatively correlated with the firm-specificity of human capital and with loss aversion. The latter correlations imply that individuals that have a highly firm-specific human capital and that are very loss averse introduced less shares of company stock into the ESO program. Thus, they also received a smaller number of options. The correlations with the first two variables are significant at the 1%-level (apart from one correlation between the RSI in g=1 and the HC variable which was significant at the 10%-level), while the correlations with the latter variable (loss aversion) are significant at the 5%-level. All other individual-level variables were not significantly correlated with the RSI variables.

[37] Recall that wealth is proxied by the grade level in the firm. Higher grades (lower value of the variable *Wealth*) imply higher levels of wealth.

myopia are related to option values and exercise decisions. The coefficient estimate of the frequency by which employees supervise their exercise gains is, however, significantly correlated with option valuations. The more often individuals checks their potential exercise gains, the higher they value their option packages. Although not reported in this table, we further find that those individuals that have a higher number of unexercised options, place higher values on their ESOs.

Table 8 complements the results in Table 7 and records sacrificed option lives and subjective option values partitioned by whether the realization of a certain rational or psychological variable is high or low. It further presents p-values of a two-sample Wilcoxon rank-sum test (Mann-Whitney test) comparing the mean values of a certain variable for the high and low realizations. The variables and their respective realizations (high/low) are defined in Table 3.[38] The findings reinforce our conclusion that risk aversion only poorly explains the observed variation in exercise decisions and option values. The differences for sacrificed option lives and option values are neither economically large nor statistically significant for the two risk aversion groups.[39] The table also shows that the option value of a loss averse individual is 29.81 Euro compared with 33.96 Euro for a less loss averse person (p-value = 0.0865). Individuals who are optimistic about the stock market value their option with 33.52 Euro, while less optimistic managers placed an average value of only 28.96 Euro on their ESOs (the difference is statistically different with p-value = 0.0513).[40] The results for our overconfidence variables confirm the general conclusions we drew on the basis of the correlation analysis in Table 7.

[38]Note that the analysis in Table 8 uses less information than the correlation analysis in Table 7. It is therefore not surprising that some variables turned out to be significant in the correlation analysis but not in grouping analysis.

[39]This is the case for both measures of risk aversion.

[40]The average option value for employees that are very optimistic about company stock is also economically higher than the option value for the less optimistic employees (even though the difference is not statistically significant anymore).

Table 8: **Determinants of Exercise Decisions and Subjective Option Values**

This table records the *Option Life Sacrificed* for g=1 and g=2 and subjective option values for g=3 partitioned by whether the realization of a certain rational or psychological variable is high or low. It further presents p-values of a two-sample Wilcoxon rank-sum test (Mann-Whitney test) comparing the mean values of a certain variable for the high and low realizations. The variables and their realizations (high/low) are defined in Table 3. The table further contains the number of observations (Obs.) for the respective variable realizations.

	Risk Aversion 1			*Risk Aversion 2*			*Stockholdings*			*Wealth*			*Firm-specificity of HC*		
	High	Low	p-value	High	Low	p-value	High	Low	p-value	High	Low	p-value	High	Low	p-value
Option Life Sacrificed g=1	0.8116	0.8072	0.8705	0.8002	0.8181	0.9077	0.8083	0.8102	0.6114	0.8135	0.7105	0.0197	0.8351	0.7800	0.7763
Obs.	28	34		21	36		32	30		70	112		33	29	
Option Life Sacrificed g=2	0.7623	0.8394	0.7594	0.8026	0.8078	0.3022	0.8783	0.7259	0.4353	0.8630	0.7080	0.0005	0.8088	0.7997	0.1269
Obs.	28	34		21	36		32	30		70	112		33	29	
Subjective Option Value g=3	30.59	31.71	0.5916	29.57	31.86	0.3540	32.77	29.60	0.1345	31.33	31.12	0.9531	29.70	33.00	0.1240
Obs.	27	34		21	35		31	30		27	34		33	28	

	Loss Aversion			*Optimism Company*			*Overconfidence Company*			*Optimism Market*			*Overconfidence Market*		
	High	Low	p-value	High	Low	p-value	High	Low	p-value	High	Low	p-value	High	Low	p-value
Option Life Sacrificed g=1	0.8207	0.8050	0.5180	0.8024	0.8810	0.7681	0.8422	0.8144	0.7236	0.8015	0.8852	0.1120	0.8329	0.8250	0.8441
Obs.	31	24		27	27		23	21		27	27		20	21	
Option Life Sacrificed g=2	0.8202	0.7863	0.2181	0.7871	0.8653	0.2995	0.8175	0.7936	0.5927	0.7912	0.8981	0.2523	0.7967	0.8490	0.5328
Obs.	31	24		27	27		23	21		27	27		20	21	
Subjective Option Value g=3	29.81	33.96	0.0865	32.56	29.12	0.1514	29.09	32.76	0.1425	33.52	28.96	0.0513	29.37	33.95	0.0699
Obs.	31	23		27	26		22	21		27	26		19	21	

	Narrow Bracketing			*Myopia*			*Frequency Supervision*		
	High	Low	p-value	High	Low	p-value	High	Low	p-value
Option Life Sacrificed g=1	0.8040	0.8200	0.8650	0.8301	0.7925	0.7798	0.7006	0.8504	0.8986
Obs.	38	22		22	39		18	43	
Option Life Sacrificed g=2	0.7997	0.8078	0.6838	0.7464	0.8324	0.1687	0.7223	0.8357	0.4565
Obs.	38	22		22	39		18	43	
Subjective Option Value g=3	30.76	32.00	0.5251	29.29	32.49	0.1696	35.71	29.60	0.0244
Obs.	37	22		21	39		17	43	

5.2 Intertemporal Consistency of Exercise Decisions

5.2.1 Theory and Predictions

Having studied determinants of option values and exercise decisions, the question arises whether employees exercise their options *over time* in a way that is economically consistent. An understanding of changes or stability of exercise behavior over time is crucial for various reasons. It is, for example, important for a precise estimation of the expected lifetime of new option grants which is needed for the valid estimation of the accounting costs of stock options. Accounting rules allow firms to use past exercise data to estimate to expected life of newly granted options. If exercises change heavily over time, then using past exercise patterns to predict the future expected lifetime of options is rather problematic.

We have seen in the previous subsection that the exercise behavior of an individual i is driven by a vector of personal characteristics (let this vector be X_i). X_i includes variables that were derived from rational ESO models as well as from psychological evidence, i.e. X_i = (*Risk Aversion*, *Stockholdings*, *Wealth*, *Loss Aversion*, *Optimism*, ...)'. This parameter vector naturally influences individuals' exercise decisions *both* in the first *and* in the second option grant. If we assume that the elements of the vector are constant over time, then economic theory suggests that exercise decisions should be intertemporally consistent.[41] Intertemporal consistency thereby means that the sacrificed option lives of individual i should be statistically the same across the two ESO grants. If, for example, risk aversion of individual i is assumed to be constant over time, then it should have on average the same effect on the sacrificed option life in the first and in the second grant. The same reasoning applies to the remaining set of variables and hence to entire vector X_i. This leads us to the following hypothesis on the intertemporal consistency of individuals' exercise decisions:

Hypothesis 2 (Time Consistent Exercise Behavior):

If we assume that the variables influencing the exercise decisions are constant over time, then sacrificed option lives have to be statistically the same across the two option grants.

[41] For evidence supporting the underlying assumption, see, e.g., Glaser et al. (2004). Moreover, we have to assume that firm characteristics and potential macroeconomic determinants also stay constant over time. Given the short time horizon we study, these assumptions should be rather unproblematic.

5.2.2 Results

To investigate whether individuals really act intertemporally consistent, we first calculated correlation coefficients between the sacrificed option lives in g=1 and g=2. The respective correlation coefficient equals 0.4429 and is significant at the 1%-level (p-value = 0.0000, n = 131). This correlation suggests that individuals that exercised early in one grant also did so in the second one. A linear regression of *Option Life Sacrificed* in g=1 on *Option Life Sacrificed* in g=2 confirms our results.[42] However, the hypothesis that the coefficient of *Option Live Sacrificed* in g=2 is equal to one, which would imply the perfect intertemporal consistency of option exercises, can be rejected at the 10%-level using a standard F-Test (p-value = 0.0805).

Figure 9 plots the distribution of the differences in the sacrificed option lives between the first and the second option grant (Difference $\equiv$ *Option Life Sacrificed*$_{g=2}$ - *Option Life Sacrificed*$_{g=1}$). The mean (median) value of this differences equals 0.031 (0.067), and the hypothesis that the difference is equal to 0 can be rejected at the 1%-level. This evidence further supports the conclusion that individuals' exercises are in general not perfectly consistent over time.[43]

We can therefore summarize that we have found some evidence for the consistency in exercise patterns over time: sacrificed option lives were significantly positively correlated across the two ESO grants. However, we found no evidence for a perfect intertemporal consistency and can therefore reject the hypothesis that employees show identical exercise patterns over time.[44]

[42] *Option Life Sacrificed*$_{g=1}$ = 0.155 + 0.761 *Option Life Sacrificed*$_{g=2}$, with R^2 = 0.1961, n = 131, and with the coefficient of the regressor being significant at the 1%-level.

[43] An individual-level analysis shows that twenty-six individuals exercised options from the two grants at the same day, while 14 more individuals exercised within +/- 3 days.

[44] An alternative explanation of our finding would be that the parameter vector X_i has changed over time. Given the non-panel structure of our survey data set, we unfortunately can not test whether time-varying individual characteristics account for our findings.

5.3 Consistency of Exercise Decisions and Subjective Option Values

5.3.1 Theory and Predictions

Having studied intertemporal option exercises, we now turn to the question whether option valuations revealed by individuals' exercise decisions and subjective option valuations elicited in our survey are also consistent with each other. This type of analysis is important as some researches focus in their modelling approaches on subjective option values, while others rather look at individual-level exercise decisions.

We have seen in Subsection 5.1 that both modelling approaches make consistent predictions for a given vector of individual characteristics X_i: lower option values are associated with earlier exercise decisions. As a consequence, we expect that rational individuals act consistently in the sense that those people that place high values on their stock options also exercise at later points in time. This prediction once again builds on the assumption that the individual characteristics are stable over time. We can hence formulate the following testable hypothesis:

Hypothesis 3 (Exercise Behavior and Subjective Option Values):

If we assume that the variables influencing both exercise decisions and subjective option values are constant over time, then higher option values are significantly associated with later exercise decisions.

5.3.2 Results

Table 9 presents pairwise correlations between the two *Option Life Sacrificed* variables (for g=1 and g=2) and the subjective option values (for g=3). It further includes the significance level of each correlation coefficient (in parentheses) as well as the number of observations used in calculating the correlation coefficient (Obs.). It shows that both exercise measures are negatively correlated with the stated option values (Rho = -0.4467 and Rho = -0.0373, respectively). Even though the coefficients show the predicted signs, the correlation coefficient for the second grant is economically very low and statistically insignificant. If we run a simple regression of the elicited option values on *Option Life*

Table 9: **Relationship between Exercise Decisions and Subjective Option Values**

This table presents pairwise correlations between the variable *Option Life Sacrificed* (in g=1 and g=2) and the elicited subjective option values (for g=3). It further includes the significance level of each correlation coefficient (in parentheses) as well as the number of observations used in calculating the correlation coefficient (Obs.). * indicates significance at 10%, ** indicates significance at 5%, *** indicates significance at 1%.

		Option Life Sacrificed (g=1)	**Option Life Sacrificed (g=2)**
Subjective	Rho	-0.4467***	-0.0373
Option Value	p-value	(0.0003)	(0.7752)
(g=3)	Obs.	61	61

Sacrificed in g=1 and g=2, respectively, we find similar results that also suggest that exercises and option values are only weakly related.[45]

We can therefore conclude that higher subjective option values are associated with later exercise decisions only in the first ESO grant. The results for the second grant show that exercise decisions and option values are not significantly related. Our evidence of this subsection therefore provide only weak support for our hypothesis on the cross-sectional consistency of exercise decisions and option values.

6 Conclusion

Stock option programs constitute an important economic domain both for the issuing companies and for their employees. Little is known, however, about which individual variables actually drive exercise patterns, and how employees value their stock options. This lack of research is merely due to data limitations about employee-by-employee exercise transactions and subjective option values. Understanding these topics is crucial for various

[45]Regression results for the first grant: Subjective Option Value = 43.35 - 14.97 *Option Life Sacrificed*$_{g=1}$, with R^2 = 0.1996, n = 61, and with both the coefficient of *Option Life Sacrificed*$_{g=1}$ and the intercept being significant at the 1%-level. Regression results for the second grant: Subjective Option Value = 32.03 - 1.01 *Option Life Sacrificed*$_{g=2}$. The R^2 of this regression is extremely low ($R^2 = 0.0014$), and the coefficient of our exercise variable is not only low but also highly insignificant (p-value = 0.775).

reasons ranging from estimation procedures for the accounting costs of ESO programs to efficient contracting.

We studied the following set of related research questions to provide a contribution to a better understanding of the mechanics behind exercises decisions and option values: How do employees exercise and value stock options? What are the determinants of exercise decisions and subjective option values? Do individuals exercise options from different grants in a consistent way? Are subjective option values consistent with individuals' exercise decisions?

To study these issues, we were able to use a unique data set combing individual-level option exercises with survey-based subjective option values and detailed personal characteristics on a wide set of variables.

Our main findings can be summarized as follows. Employees in our data set exercised their stock options well before expiration. The median individual sacrificed more than 90% of the option's lifetime by exercising early. Employees hereby sacrificed a significant proportion of the option's fair value (about 20%). Interestingly, we found that employees exercising at later points in time made a higher per-option profit than those exercising earlier. When individuals were asked how they subjectively value a real stock option, they stated values that were substantially above the fair option value. The average manager assigned a value of 31.21 Euro to an option with a fair value of roughly 26 Euro. Our survey data suggested that the employees in our data set are highly undiversified with almost 42% of their equity holdings invested in company stock. The average individual predicted a company stock return of 20.87% over a five-year horizon with responses varying heavily between -28.90% and 60%. Moreover, most of the managers suffered from narrow bracketing and were very loss averse.

Turning to the question of how individual characteristics affect exercises and option values, we found that measures of risk aversion and exercise decisions are unrelated. This finding is inconsistent with rational option models that use risk aversion as a core ingredient to rationalize early exercises. We also found no statistically significant relationship between subjective option values and risk aversion. Loss aversion did a better job than risk aversion in explaining the heterogeneity in option values. We found that employees

with a highly firm-specific human capital discounted their options more heavily. Moreover, we provided evidence suggesting that more wealthy managers exercise later as they have more funds to diversify. Overall, our results indicated that psychological variables are significantly correlated with elicited option values (but surprisingly not with exercise decisions). More specifically, we found that optimism and overconfidence measures were significantly related to option values. We documented that managers that are very optimistic about company stock place higher values on their ESOs. This finding is consistent with the sentiment hypothesis presented in Oyer and Schaefer (2004) and Bergman and Jenter (2004). Their models suggested that excessive optimism causes individuals to overvalue ESOs. We also found that more overconfident employees put lower values on stock options which is consistent with the findings in Sautner and Weber (2005) and the theory in Henderson (2002).

Regarding the question whether employees exercise options from different grants in a consistent way, we provided some evidence for an intertemporal consistency of option exercises. When employees exercise early in one grant, they also do so in a second one. However, we found no evidence for a perfect consistency in exercise patterns and rejected the hypothesis that employees show identical exercise behavior over time. Turning to our last research question, we offered only weak support for the hypothesis that higher option values are generally associated with later exercise decisions. This finding is surprising given that ESO models usually regard subjective option values and exercise decisions as perfect substitutes.

References

Benartzi, Shlomo, 2001, Excessive extrapolation and the allocation of 401(k) accounts to company stock, *Journal of Finance* 56, 1747–1764.

Bergman, Nittai, and Dirk Jenter, 2004, Employee sentiment and stock option compensation, Working Paper, MIT Sloan School of Management.

Bettis, J. Carr, John M. Bizjak, and Michael L. Lemmon, 2003, The costs of employee stock options, Working Paper, Arizona State University, Portland State University, and University of Utah.

——— , 2005, Exercise behavior, valuation, and the incentive effects of employee stock options, *Journal of Financial Economics* 76, 445–470.

Black, Fischer, and Myron Scholes, 1973, The pricing of options and corporate liabilities, *Journal of Political Economy* 81, 637–659.

Carpenter, Jennifer N., 1998, The exercise and valuation of executive stock options, *Journal of Financial Economics* 48, 127–158.

Core, John E., and Wayne Guay, 2001, Stock option plans for non-executive employees, *Journal of Financial Economics* 61, 253–287.

——— , and David F. Larcker, 2003, Executive equity compensation and incentives: A survey, *Economic Policy Review* 9, 27–50.

DeBondt, Werner F.M., 1998, A portrait of the individual investor, *European Economic Review* 42, 831–844.

Degeorge, Francois, Dirk Jenter, Albert Moel, and Peter Tufano, 2004, Selling company shares to reluctant employees: France Telecom's experience, *Journal of Financial Economics* 71, 169–202.

Glaser, Markus, Thomas Langer, and Martin Weber, 2004, Overconfidence of professionals and lay men: Individual differences within and between tasks?, Working Paper, University of Mannheim.

Glaser, Markus, and Martin Weber, 2004, Overconfidence and trading volume, Working Paper, University of Mannheim.

Hall, Brian J., and Kevin J. Murphy, 2000, Optimal exercise prices for executive stock options, *American Economic Review* 90, 209–214.

——— , 2002, Stock options for undiversified executives, *Journal of Accounting and Economics* 33, 3–42.

Heath, Chip, Steven Huddart, and Mark Lang, 1999, Psychological factors and stock option exercise, *Quarterly Journal of Economics* 114, 601–628.

Hemmer, Thomas, Steve Matsunaga, and Terry Shevlin, 1996, The influence of risk diversification on the early exercise of employee stock options by executive officers, *Journal of Accounting and Economics* 21, 45–68.

Henderson, Vickey, 2002, Stock based compensation: Firm-specific risk, efficiency and incentives, Working Paper, University of Oxford.

Hodge, Frank, Shiva Rajgopal, and Terry Shevlin, 2005, How do managers value stock option and restricted stock?, Working Paper, University of Washington Business School.

Huberman, Gur, and Paul Sengmüller, 2004, Performance and employer stock in 401 (k) plans, *Review of Finance* 8, 403–443.

Huddart, Steven, 1994, Employee stock options, *Journal of Accounting and Economics* 18, 207–213.

——— , and Mark Lang, 1996, Employee stock option exercise: An empirical analysis, *Journal of Accounting and Economics* 21, 5–43.

Hull, John, and Alan White, 2004, How to value employee stock options, *Financial Analysts Journal* 60, 114–119.

Ikäheimo, Seppo, Nuutti Kuosa, and Vesa Puttonen, 2004, The true and fair value of executive stock option valuation, Working Paper, Helsinki School of Economics.

Ito, Takatoshi, 1990, Foreign exchange rate expectations: Micro survey data, *American Economic Review* 80, 434–449.

Kahneman, Daniel, and Amos Tversky, 1979, Prospect theory: An analysis of decision under risk, *Econometrica* 47, 263–291.

Klos, Alexander, and Martin Weber, 2003, Experimental evidence on the relationship between common measures of risk aversion and portfolio choice, Working Paper, University of Mannheim.

Lambert, Richard A., and David Larcker, 2001, How employees value (often incorrectly) their stock options, knowledge@wharton, University of Pennsylvania.

Lambert, Richard A., David F. Larcker, and Robert E. Verrecchia, 1991, Portfolio considerations in valuing executive compensation, *Journal of Accounting Research* 29, 129–149.

Markowitz, Harry M., 1952, Portfolio selection, *Journal of Finance* 7, 77–97.

Massey, Cade, 2003a, When and why employees exercise stock options, Working Paper, Duke University.

——— , 2003b, How employees value stock options, Working Paper, Duke University.

May, Don O., 1995, Do managerial motives influence firm risk reduction strategies, *Journal of Finance* 50, 1291–1308.

Meulbroek, Lisa K., 2002, Company stock in pension plans: How costly is it?, Working Paper, Harvard Business School.

Murphy, Kevin J., 1999, Executive compensation, in O. Ashenfelter, and D. Cards, ed.: *Handbook of Labor Economics* p. Volume 3 (Amsterdam: North Holland).

Oyer, Paul, and Scott Schaefer, 2005, Why do some firms give stock options to all employees?: An empirical anaylsis of alternative theories, *Journal of Financial Economics* 76, 99–133.

Poteshman, Allen M., and Vitaly Serbin, 2003, Clearly irrational financial market behavior: Evidence from the early exercise of exchange traded stock options, *Journal of Finance* 58, 37–70.

Sautner, Zacharias, 2005, A survey on employee stock options, Working Paper, University of Mannheim.

——— , and Martin Weber, 2005, Stock options and employee behavior, Working Paper, University of Mannheim.

Sharpe, William F., 1964, Capital asset prices: A theory of market equilibrium under conditions of risk, *Journal of Finance* 19, 425–442.

Weinstein, Neil D., 1980, Unrealistic optimism about future life events, *Journal of Personality and Social Psychology* 39, 806–820.

Figure 1: Exercise Pattern over Time (Aktiengesellschaft)

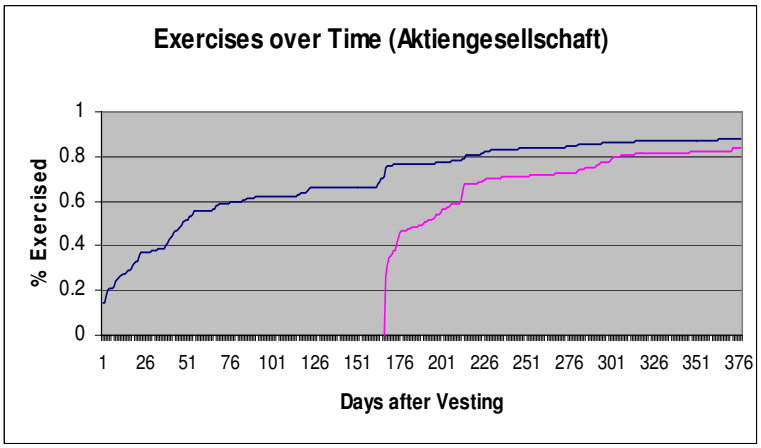


Figure 2: Exercise Pattern over Time (Group)

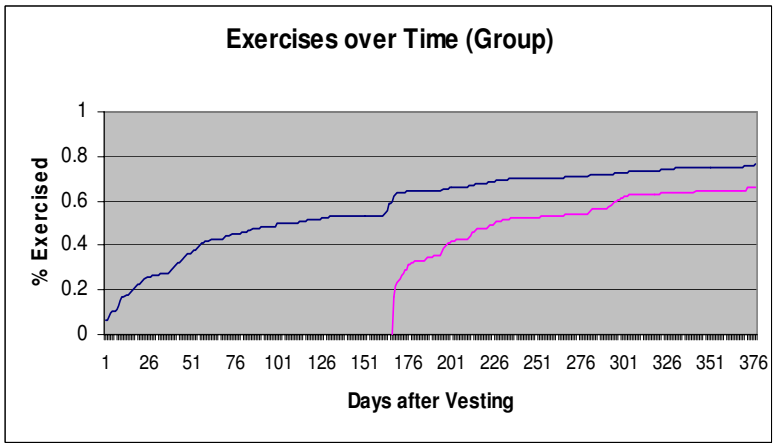


Figure 3: Distribution of Option Life Sacrificed (g=1)

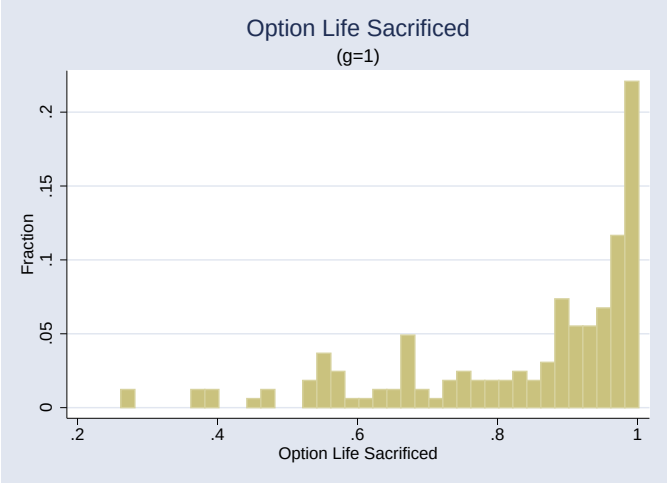


Figure 4: Distribution of Option Life Sacrificed (g=2)

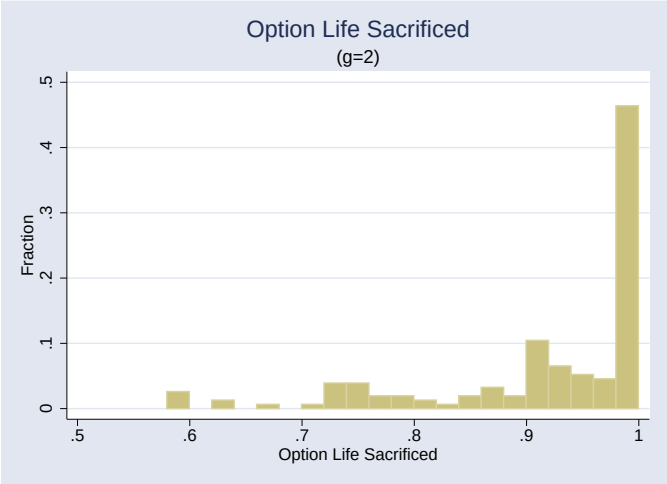


Figure 5: Exercise Gains and Exercise Behavior (g=1)

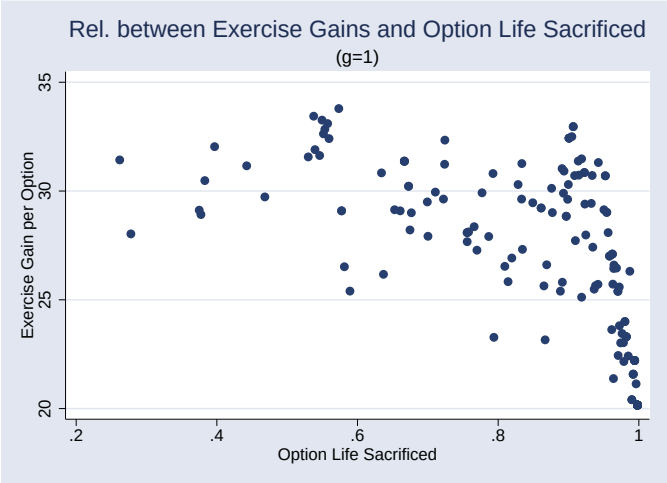


Figure 6: Exercise Gains and Exercise Behavior (g=2)

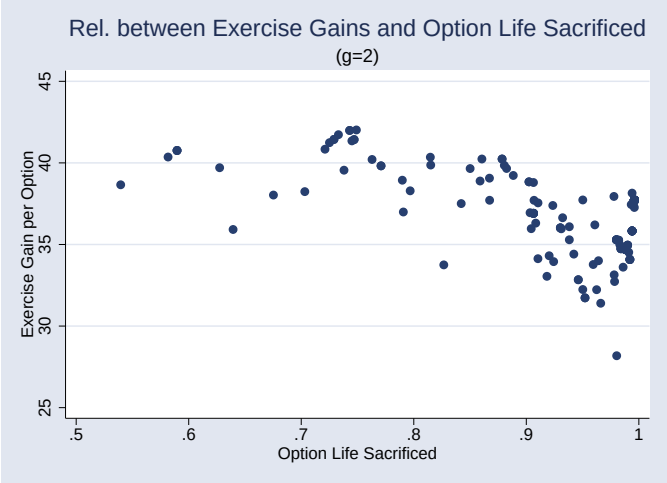


Figure 7: Captured Fair Values and Exercise Behavior (g=1)

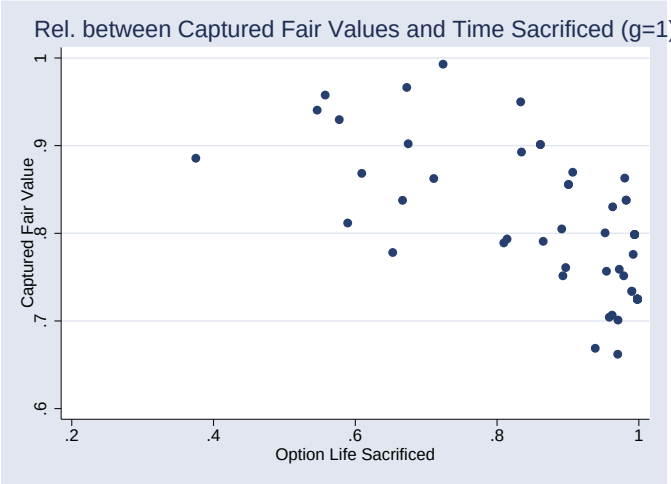


Figure 8: Distribution of Subjective Option Values in Euro (g=3)

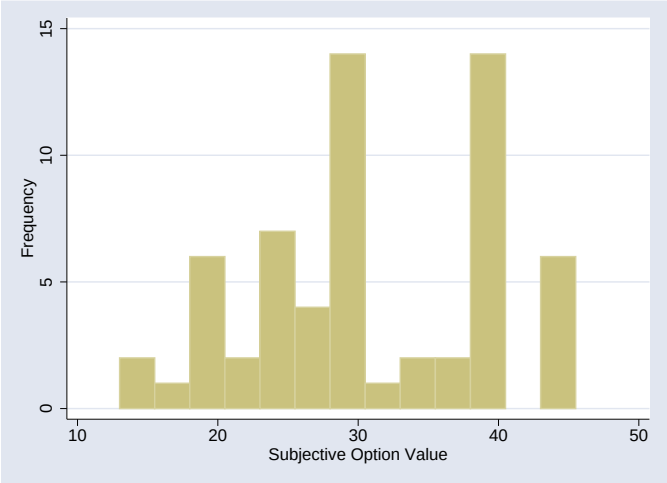
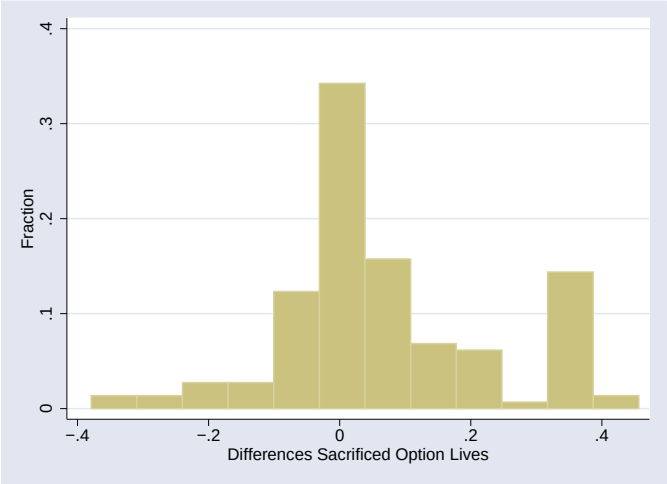


Figure 9: Differences in Sacrificed Option Lives (g=1 and g=2)



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