Employee Stock Option Exercise Behavior and Firms' Claims about Employee Stock Option Expense

by

Brian Young

A Dissertation Presented in Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy

Approved April 2011 by the
Graduate Supervisory Committee:

Jeffrey Coles, Chair
Ilona Babenka
Michael Hertzel

ARIZONA STATE UNIVERSITY

May 2011

ABSTRACT

This dissertation analyzes the reliability of reported employee stock option (ESO) expense, the determination of expected life of ESOs, motivations to manipulate ESO expense, and the impact of noise in ESO expense on subsequent stock price returns. Based on unique data, this is the first paper to measure average historical ESO life for all employees of a broad set of firms. I find average life has a mean of 4.12 years. Average life is reduced by 0.38 years per 10 percentage point increase in volatility, and industry effects explain an additional 7% of the variation. Reported expected life increases 0.37 years per year of historical life and an additional 0.16 years per year of age of the outstanding options. Deviations of reported volatility and life from benchmarks have positive correlations with deviations from own reporting history. Using stated assumptions rather than benchmark assumptions drops (increases) ESO expense by 8.3% (17.6%) for the 25th (75th) percentile firm. The change in earnings per share decreases (increases) by $0.019 ($0.007) for the 25th (75th) percentile firm. In contrast to the general findings of the extant literature, I do not find a direct relationship between incentives to manipulate earnings and deviations from benchmark values. Nevertheless, deviations for both life and volatility are slightly correlated thus demonstrating subtle manipulation or irrational expectations. Absolute values of deviations from benchmarks have a positive relationship with subsequent stock price volatility suggesting noise in reported stock option expense results in stock price noise. Deviations from

benchmarks and subsequent cumulative abnormal returns have statistically significant results but are difficult to interpret.

DEDICATION

I dedicate this paper and my Ph.D. to my wife Robin and my daughters Madeleine and Avery. The entire family has sacrificed for this degree, and I consider the degree and its rewards to belong to the entire family.

ACKNOWLEDGMENTS

I would like to thank my committee for giving this project careful attention and providing extremely valuable feedback. As this is my first complete research project, I had much to learn about project execution and presentation. Their guidance was invaluable for completion of this paper. Dr. Jeffrey Coles, the committee chair, has invested an inordinate amount of time by meeting with me on a weekly basis over the last two years to discuss this and other projects. Dr. Michael Hertzel has been a mentor from the first day in the program, gave me my first start with a research project, and has provided valuable feedback with this project as well. Dr. Ilona Babenko has provided invaluable attention to detail and hands-on research expertise. The committee has no doubt been a big part of this paper and my training as a whole.

In addition to the committee I have received extensive guidance from Dr. John Bizjak and Dr. J. Carr Bettis. Dr. Bizjak has spent a great deal of time discussing the research approach of this and other projects. Dr. Bettis has also given much of his valuable time to this project. Additionally, he has provided me with foundational data produced at the expense of two firms which he owns. Without these data this project would be very limited in terms of sample size and the results would likely have very little impact.

Finally, I would like to thank the Michael Cohn, Mark Beal, and Daniel Tram, all who are outstanding honors undergraduates at Arizona State University. Their assistance with various data collection projects helped accelerate this paper at a time of great importance for the job market.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Because employee stock options (ESOs) cannot be sold, the owner must exercise the option should he or she desire the cash from the option before its expiration. Early exercise sacrifices the remaining option value yet it is quite common. Theoretical papers have presented models which propose macroeconomic, firm, and individual characteristics that affect the likelihood of exercise and the length of time ESOs are held.[1] Empirical papers have attempted to test these models, but ESO exercise data are not publicly available.[2] Thus prior studies have relied on proprietary data for all individuals of a few firms or executives only for a broad set of firms.

This dissertation presents a novel methodology for deriving the average life of all ESOs for a large set of firms based on SEC filings. With these data, I test macroeconomic, firm, and individual characteristics that drive average ESO life for a wide cross-section of firms. This is the first paper to test what is claimed about expected life of ESOs (for expensing purposes) against the firm's prior ESO exercise history. Through the use of benchmark values for reported expected life and volatility, I test for the presence of stock options expense manipulation and the effect that deviations from the benchmark values may have on stock price.

I find stock price volatility, industry, vesting terms, and concentration of options with the top five executives drive average ESO life. Volatility has a

---

[1] See Huddart (1994) and Carpenter (1998).

[2] See Huddart and Lang (1996), Carpenter (1998), and Bettis, Bizjak, and Lemmon (2005).

negative relationship with ESO life while average vesting time and concentration have a positive relationship. The results are qualitatively similar to studies based on executives only, but the explanatory power of the models is much greater. I find that reported expected life has a positive relationship with the average ESO life of the firm, the life of the options that have yet to be exercised, and median industry value. I do not find direct evidence of a relationship between incentives to manipulate stock option expense and deviations of expected life and volatility from benchmark values. Nevertheless, these deviations have a slightly positive correlation with each other rather than the negative relationship theory would predict. This indicates a more subtle approach to manipulation or irrational expectations of the future. Deviations from benchmarks are related to subsequent excess stock price volatility suggesting reported values have an effect on the price discovery process. I find deviations from benchmarks impact subsequent returns but the mechanics of the effect remain undefined.

A better understanding of ESO exercise behavior and accuracy of reported ESO valuation assumptions have implications for contract design, price discovery, regulation, and public policy. From a contracting perspective, the principal may construct a more efficient compensation package if he or she understands the duration of the option under various circumstances. In term of the impact on price, reported valuation assumptions affect the value of stock option expense and net income. Thus claims of expected life and deviations from reasonable values may affect stock price as investors evaluate future earnings, outstanding ESO liability, and employee incentives. Accordingly, investors, policy makers, regulators, and the media have an interest in accurate reporting.

The rest of this dissertation is organized as follows. Chapter 2 provides a background for SFAS 123 and reviews the prior literature in detail. Chapter 3 describes the research design and formation of a unique measure for average life of options held by employees. Chapter 4 describes the data and factors that explain variations in historical ESO life and reported expected life. Chapter 5 analyzes possible motives to manipulate ESO expense and the effect of deviations from the benchmarks on subsequent price. The conclusion summarizes the findings.

CHAPTER 2

BACKGROUND AND LITERATURE REVIEW

The Financial Accounting Standards Board (FASB) proposed a rule in 1993 that would require firms to change the way in which they account for ESO expense. Under the old method of accounting for ESOs, firms were required to expense only the intrinsic value of options granted, which is the exercise price subtracted from market price of the stock at the time of grant. Accordingly, most firms maintained a policy of granting options at the money and reported no stock option expense. Under the proposed ruling, firms would determine the present value of the options granted and expense them ratably over the course of the vesting period. Facing intense opposition to the ruling, FASB weakened the final ruling which only required firms to state in a footnote what impact ESO expense would have on net income had the firm followed the originally proposed ruling. This ruling, known as SFAS 123, became effective for all fiscal years ending December 1996. In December 2004, with enough accounting scandals of public firms available as evidence for its case, FASB was able to revise SFAS 123 to look like the originally intended ruling. Hence SFAS 123(R) became effective for fiscal years ending June 2006 and required all firms to expense stock options based on a fair market value (FMV) as determined by the firm.

The intention of GAAP is that a firm values the options at the same price it would have to pay an outside agent to assume responsibility for the options. Nevertheless, there are no equivalent securities the firm can use to value the options since ESOs have vesting conditions and are not tradable. Thus the firm could employ a lattice model or the Black-Scholes (1973) valuation model to determine the FMV. Nevertheless, these models pose a problem when applied to ESOs. The value of a call option with any remaining life will always exceed its intrinsic value. However, per the utility model posed by Huddart (1994), the option holder may derive greater utility from exercising the option at some point in time before option expiration. In that event, due to non-tradability of ESOs, the employee will exercise the option thus sacrificing some portion of the present value of the option. Empirical studies by Huddart and Lang (1996), Carpenter (1998), and Bettis et al (2005) provide direct evidence of early exercise. The Black-Scholes model and the typical lattice model assume the option is held to full term by somebody since an option holder will always receive more for the option by selling it rather than exercising it. Thus the value derived from the entire contractual length is incorporated into the value of the option. FASB recognized this stylized fact and recommended using the expected holding life of the option in place of contractual term. This estimated value affects the option value directly and indirectly as the volatility, risk-free rate, and dividend assumptions are based on the same time period.

The guidance provided by SFAS 123 and 123(R) acknowledge that the firm must use its own judgment to determine these model inputs. To estimate expected life, firms are instructed to consider the vesting period, the average historical holding term of similar options, and expected volatility. Also, expected term may be the output of a lattice model where employees follow an exercise rule based on stock price to exercise price. To estimate volatility, firms are instructed to consider historical volatility, length of time firm has traded publicly, and mean reversion tendencies of volatility. Dividends reflect management's best estimate and the risk-free rate is based on zero-coupon government issues. The statement instructs management to combine the above factors in a way that best reflects estimates of the future and allows for assumptions that produce the low range of FMV when a range of options exist and management believes no one choice is better than the other.

Clearly the guidelines for determining valuation model assumptions leave room for both variability in beliefs of future conditions and opportunistic ESO expense reduction. Table 1 demonstrates the impact a change in expected life or volatility can have on stock option expense and earnings. A firm has great discretion in selecting estimates and the impact is material. Analysis of these issues in the extant literature falls into three categories: ESO exercise behavior, ESO reporting manipulation, and price relevance of stock options.

Early exercise of ESOs is a persistent behavior predicted by theory and documented by several papers. Huddart (1994) present models that demonstrate a utility-maximizing, risk-averse individual may exercise an inalienable ESO before the contractual term ends. Likelihood of early exercise increases with stock price volatility and risk-aversion. Carpenter (1998) extends the model to account for outside wealth and gains from change of employment. Liklihood of early exercise is decreasing in outside wealth and increasing in the value gained by switching employers. Murphy (1999) demonstrates that the certainty equivalent of an option with an FMV of $17.60 is approximately $7.88, $1.62,

Table 1

Hypothetical Sensitivity Analysis of Assumption Deviations

Panel A provides the change in the Fair Market Value of options granted had the volatility and life assumptions varied as stated. Panel B repeats the process for Earnings Per Share under the assumption that the entire grant is expensed for the year of the grant. The data cover 1,756 firms from 1998 to 2008.

Panel A: Percentage Change in Fair Market Value for Different Scenarios

		Percentile				
Scenario	N	5th	25th	50th	75th	95th
Δ Life=-1, Δ Vol = 0	13,790	-13%	-11%	-9%	-6%	-4%
Δ Life=0, Δ Vol = -0.10	13,790	-34%	-24%	-18%	-12%	-9%
Δ Life=-1, Δ Vol = -0.10	13,790	-41%	-33%	-27%	-21%	-16%
Δ Life= ±1, Δ Vol = ±0.10	13,790	-58%	-50%	-42%	-34%	-27%

Panel B: Change in Earnings Per Share ($) for Different Scenarios

		Percentile				
Scenario	N	5th	25th	50th	75th	95th
Δ Life=-1, Δ Vol = 0	13,435	0.001	0.004	0.010	0.024	0.052
Δ Life=0, Δ Vol = -0.10	13,435	0.003	0.010	0.023	0.045	0.077
Δ Life=-1, Δ Vol = -0.10	13,435	0.005	0.014	0.034	0.067	0.122
Δ Life= ±1, Δ Vol = ±0.10	13,435	0.010	0.028	0.066	0.133	0.242

and $0.39 for an individual with 50% of her wealth in the firm and a relative risk aversion of 1.0, 2.0, and 3.0 respectively. For the individual with a relative risk aversion of 2.0, the certainty equivalent for the same option is approximately $7.80, $3.57, and $1.62 for a percentage of wealth in the firm of 50%, 75%, and 90% respectively. Prior literature also provides empirical results for early exercise. Carpenter (1998) studies exercise data for executives at 40 firms based on insider forms 3, 4, and 5 filings, where observation is conditional upon exercise. The data follow the exercise history for one specific grant for each firm and the contractual life of the entire sample falls between 1979 and 1994. The sample's mean holding period for options exercised is 5.83 years and the mean stock price to strike price ratio is 2.75. Huddart and Lang (1996) collect grant and exercise information for ESOs awarded to 58,316 employees across eight firms via voluntary survey response. The sample period is vague but appears to be 1980 to 1992. The holding period of options exercised has a mean of 3.63 for firms granting 10 year options and 1.23 years for firms granting 5 year options. Bettis et al (2005) utilize Form 3, 4, and 5 filings for a broader data set than Carpenter (3,966 firms between 1996 and 2002) but do not attempt to match the exercises to the grant date. Their data show that remaining contractual life of options exercised has a mean of 4.47 years.

The guidelines for determining valuation model assumptions leave room for both variability in well-intentioned estimates and opportunistic ESO expense reduction. Several papers have identified deviations of reported assumptions from benchmark values and have attempted to separate informational deviations and opportunistic deviations from noise resulting from estimates. Yermack (1998) forms the volatility benchmark using the volatility of returns for the previous 120 trading days, the risk-free benchmark using the government bond closest in term to the expected life, and the dividend yield benchmark based on dividends from the previous quarter. Expected life is used as reported. He finds that firms undervalue executive options relative to the benchmarks, unilateral modifications to the Black-Scholes value typically decrease the value, and the degree of under-reporting for executive options increases as CEO pay increases relative to peers. Hodder et al. (2006) formulate benchmarks for risk-free rate, volatility, and dividend rate using fitted values from a regression of the reported parameter against actual historical values and the average reported value for the industry. Expected life is similar except rather than using historical life of options they use the expected life reported by the firm the previous year. The paper regresses deviations from the benchmarks against proxies for incentives to disguise compensation, manage earnings, and information of future volatility. The authors conclude changing environments, earnings management motivation, and compensation disguise motivation explain some of the deviation in model assumptions. Aboody and Kasznik (2006) regress the stated FMV against a benchmark FMV, various incentives to disguise compensation, industry/year fixed effects, and controls. The benchmark FMV is similar to Yermack as well, but benchmark life is the fitted value of reported life against the vesting period, options cancelled, options exercised, and the percent of options granted to the top five executives. Their results are similar to Yermack and Hodder et al with volatility and life having the strongest results. Bartov et al. (2007) utilize traded options to test to what degree market expected volatility and historical volatility are considered in formulating the volatility model assumption. They find that both elements are utilized but selectively to lower ESO expense, especially when motivating factors are higher. Utilizing data that span both pre and post SFAS 123(R), Choudhary (2010) performs tests similar to the other papers but the regressands are both deviations from benchmarks to identify bias and the absolute value of deviations from benchmarks to identify accuracy. She finds opportunism is stronger when options are expensed and when motivations to manage earnings are higher.

One of the arguments against the original proposal of SFAS 123 was that investors did not understand the meaning of this non-cashflow change to earnings and that stock values would be irrationally decreased. This calls market valuation techniques into question since proper pricing would include the value of all outstanding options regardless of the expensing procedure. Aboody (1996) uses pre-SFAS 123 data to test if the market prices various aspects of the ESOs. His methodology is to use a modified Ohlsen (1995) model whereby price is regressed against earnings minus dividends, book value of equity, and the variable for which you wish to detect price discovery. The generalized results are that price is negatively related to number of outstanding options, the present value of options outstanding, and the present value of older options. Aboody et al (2004), using pre-SFAS 123(R) data, use the same model but include forecasted growth from analysts to capture incentive effects of options and instruments for disclosed (not expensed) option expense. They find a negative relationship between disclosed options expense and price. Bartov and Hayn (working paper), utilizing events that indicated the likelihood of passage of SFAS 123(R), find a negative relationship between CAR and the percentage impact that expensed options would have on EPS, and a positive relationship between CAR and a proxy for lack of clarity into the firm's business. Frederickson et al (2005) use a survey of valuation professionals to determine that mandatory expensed options are deemed more reliable than voluntarily expensed options which they find to be more reliable than option expenses appearing in the footnotes only. [3]

[3] One caveat of the two years before SFAS 123(R) is that firms had the option to voluntarily expense options. The sample of firms used by Choudhary (2010) show that approximately 11% of firms expensed voluntarily.

CHAPTER 3

RESEARCH DESIGN AND THE PROXY FOR AVERAGE ESO LIFE

The most unique contribution of this dissertation is the measurement of historical life of ESOs held by all employees of the firm. This chapter describes the process by which the measurement is obtained. Additionally, this chapters describe the design of benchmarks for the ESO valuation assumptions reported by firms in the 10-K. The purpose of the benchmarks is to provide a reference point from which the assumptions stated in the 10-K deviate. These deviations can then be analyzed to discuss impact on reported earnings, motivations to manipulate the numbers, and impact on subsequent price and returns.

A. Measurement of Historical Holdings

There is no known publicly available source of exercise data for all employees of the firm. Exercise behavior of corporate insiders can be observed through analysis of forms 3, 4, and 5 which serve as the basis for insider filing data. Bettis et al (2005) and Carpenter (1998) base their studies on these data, which have the advantage of providing details of option exercises including the date and the number of shares. These studies offer an excellent reference point for overall employee exercise behavior, but are inappropriate as a source of data for such a study. Models like Carpenter (1998) and Huddart (1994) predict executives will hold options longer than average employees due to greater wealth and public observation of options exercise. Thus conclusions drawn from these data may not represent the behavior of the overall set of ESO holders. Another problem with these data is they are truncated since expirations, forfeitures, and cancellations are not observed. Additionally, these data only provide information regarding a specific exercise and do not disclose valuable information about the number of options outstanding and the weighted average remaining life of those options. In contrast, Huddart and Lang (1996) gather detailed data on all employees but the results provide no cross-sectional power since the sample spans only eight firms.

I address the problems of truncation, bias, and lack of cross-sectional variation by creating a unique measure for average holdings of all employees of the firm. The 10-K reports options outstanding at the beginning and end of the year, the weighted average remaining contractual life of all outstanding options, and option activity to describe the change in options outstanding. The change in options typically includes grants, exercises, and a term or two to collect expirations, cancellations, and forfeitures. The data are presented graphically in Figure 1. I estimate the life of all options cancelled, exercised, expired, and forfeited using the following procedure:

1) The options existing at the beginning of the fiscal year will either be terminated (exercised, canceled, forfeited, or expired) at some time during the year or will remain outstanding at the end of the year. These options are represented by the first and second lines in Figure 1 respectively.
2) Assume all options granted have 9.5 years of life remaining at the end of the year (time, t).

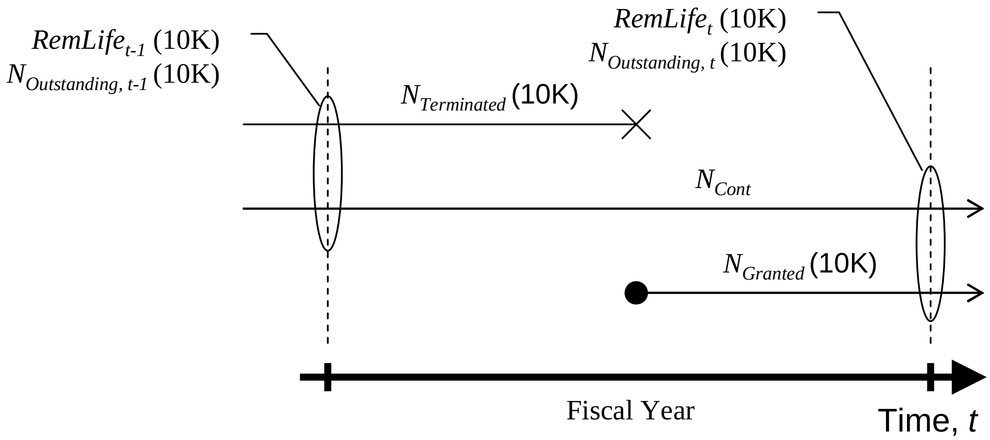


Figure 1. The flow of ESOs as presented by the 10-K and analysis technique. This figure demonstrates the analysis technique used to estimate the life of all options terminating during the fiscal year. $RemLife_{t-1}$ and $RemLife_t$ are the weighted average remaining life of all options outstanding at the beginning and end of the year respectively. $N_{Outstanding,t-1}$ and $N_{Outstanding,t}$ are the number of options outstanding at the beginning and end of the year respectively. $N_{Terminated}$ is the number of options that terminate during the year due to exercise, cancellation, forfeiture, and expiration. N_{Cont} is the number of options outstanding at the beginning of the year that remain outstanding at the end of the year. $N_{Granted}$ is the number of options granted during the year.

3) Assume the number of options outstanding, $N_{Outstanding,\ t}$, equals the sum of the number granted, $N_{Granted}$, and the number of options that were present at the beginning of the year and made it through to the end of the year, N_{cont}.
4) Using $RemLife_t$, $N_{Outstanding,t}$, N_{cont}, $N_{Granted}$, and the assumption in step 1, calculate the remaining life of the continuing options, $RemLife_{Cont,t}$.
5) $RemLife_{Cont,t-1}$ is one year greater than $RemLife_{Cont,t}$.
6) The number of options that will terminate during the year due to exercise, forfeit, cancellation, or expiration, $N_{terminated}$, is $N_{Outstanding,\ t}$ less N_{cont}.
7) Using $RemLife_{t-1}$, $N_{Outstanding,\ t-1}$, N_{cont}, $N_{Terminated}$, and $RemLife_{Cont,t-1}$ to calculate the remaining life of the terminated options, $RemLife_{Terminated,t-1}$.

8) The weighted average life of the options terminated, $Life_{terminated,\ t}$, is equal to 9.5 less $RemLife_{Terminated,\ t-1}$.

For each firm-year, the average historical ESO life at $t=T$ is the weighted average of $Life_{terminated,t}$ for the 7 years prior as shown in equation 1.

$$Life_{Hist,T} = \frac{\sum_{t=T}^{t=T-6}\left(Life_{terminated,t}\right)\left(N_{terminated,t}\right)}{\sum_{t=0}^{6}\left(N_{terminated,t}\right)} \quad (1)$$

I keep only observations with at least 5 years of data. Firm-years where there were large acquisitions or restructuring caused the number of options outstanding to change by ±5% are not included. Calculating average historical life at any point in time poses a few challenges as well. Ideally the measurement would capture the ultimate fate of all options for a specific set of options to be measured. Any measurement period that does not include the beginning and the termination of all the options in the measured set creates the following situation. Suppose the measurement period for historical ESO life is the previous seven years worth of exercises. The firm shown in Figure 2 has granted options at two times of interest. The first grant took place several years before the beginning of the measurement period. Some of the options were terminated before the measurement period while the rest, including any expirations, occurred during the measurement period. The partial effect of missing these terminations is an upward bias of historical life. The second grant took place during the fourth year of the measurement period. Some of the options were terminated during the measurement period but others are still outstanding at time *t*. The partial effect of the options outstanding is a downward bias. Thus the total effect is noise that increases as firms vary the size of their grants over time and as option exercise patterns vary over time.

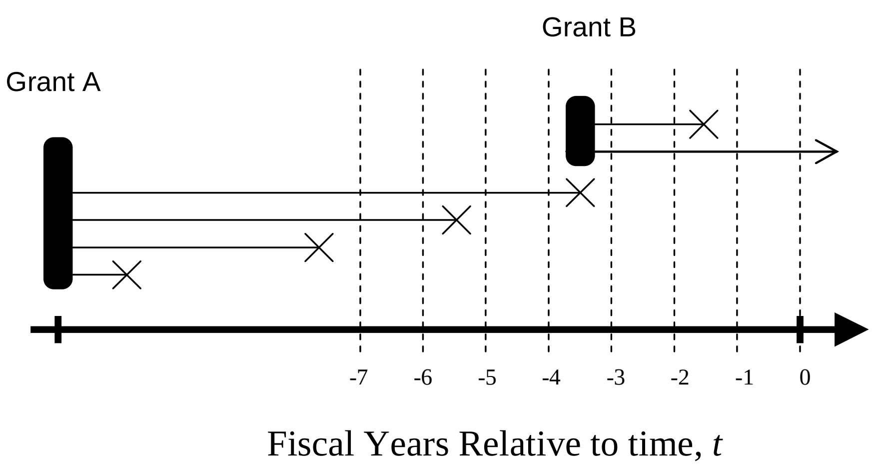


Figure 2. Exercise data that are both captured and not captured by the estimation technique. This hypothetical timeline demonstrates that the seven year measurement period will miss early exercises from Grant A and late exercises from Grant B.

B. Benchmark Design

Each benchmark is intended to provide an ideal estimate of expected volatility and expected life. Firms are instructed by SFAS 123 to consider historical volatility, length of time firm has traded publicly, and mean reversion tendencies of volatility when estimating volatility. Firms are instructed to consider the vesting period, the average historical holding term of similar options, and expected volatility when estimating expected life. I have chosen four different benchmarks for volatility and life, each with its own advantages and disadvantages:

1. Historical Results (Vol_{Hist} and $Life_{Hist}$) – For volatility this is the annualized standard deviation of the natural log of one plus the monthly return, measured over the previous five years. For expected life the benchmark is the average holding life of all options terminated during the previous seven years. The technique for measuring average life is discussed in Section A. The advantage of these measures is that they are simple and not subject to potentially mis-specified models, but have no consideration for firm qualities and industry averages.
2. Historical and Economic Estimate ($\widehat{Vol}_{Hist}$ and $\widehat{Life}_{Hist}$) – These benchmarks are fitted values from a regression of historical values on cross-sectional variables. The purpose of this benchmark is to use pooled historical data to better predict volatility and average life of ESOs held, incorporate industry averages, and lessen the impact of idiosyncratic firm history. This benchmark is subject to model misspecification.
3. Historical Reported Estimate ($Vol_{Hist10K}$ and $Life_{Hist10K}$) – These benchmarks are simply the averages of expected volatility and expected life as reported in the 10-Ks of the previous 5 years. This benchmark detects a change in reporting history with no reference to actual volatility or ESO life history. A departure from previous measures also has no implication in terms of departure neither from the true value nor towards a true value.

4. Peer 10-K and economic estimate ($\widehat{Vol}_{10K}$ and $\widehat{Life}_{10K}$) – These benchmarks are fitted values of the regressions of reported expected volatility and expected life as a function of firm characteristics, industry averages, and other control variables. This benchmark reflects the deviation from peer reported values based on industry and other economic characteristics. It is subject to misspecification and fails to identify any global bias since the mean deviation from this benchmark is zero as a result of the benchmark design.

CHAPTER 4

DATA AND ANALYSIS

This chapter describes the data used in this study and provides an analysis of the results. Section A describes the data. Section B analyzes factors driving the exercise behavior of ESOs. Section C provides results for various benchmarks. Section D analyzes incentives to manipulate the assumptions. Section E studies the effect of deviations from benchmarks on stock price.

A. Data

The data required for this study can be found in the 10-K and the proxy statements. Nevertheless, no known commercially available source collects these data. I start with a proprietary data set and enhance the data with hand-collected data.[4] The data used in this study are a smaller subset of the Compustat universe. I discuss the reduction is sample size and possible selection bias in Appendix A.

The period of this study is 1998 to 2009. For any volatility analysis, I consider all publicly traded firms with data in both Compustat and CRSP. For analysis of historical ESO life and expected life assumptions, I limit the data to firms that grant predominantly 10 year options.

To classify a firm as a 10 year firm I follow several steps. The first step is to use the proprietary data in combination with Execucomp to determine how frequently the executives of the firms get 10 year options. If the percentage is

[4] I thank Dr. J. Carr Bettis, founder and CEO of Verus research, for providing access to Verus' proprietary data.

80% or greater, the firm is considered a 10 year firm. Next I use the proprietary data to identify the cases where the 10-K clearly describes the ESO contractual term as 10 years. In addition, if the 10-K clearly states that options are not 10 year options then firms identified as 10 year firms from the proxy data are removed.

The life of ESOs is measured using the change of options outstanding data found in the 10-K as described in section A of Chapter 3. As a review, $Life_{terminated,T}$ is year T's measurement of the life of options terminated during the fiscal year. $Life_{Hist,T}$ is the weighted average of $Life_{terminated,t}$ for the previous seven years. In some cases the options outstanding from the previous year do not equal the options outstanding at the beginning of the year even after adjusting for splits. If the difference is greater than 5% then $Life_{terminated,t}$ is discarded. I require at least five of the previous seven years to have a valid measurement for $Life_{terminated,t}$. Requiring at least 5 years of data results in the earliest observation of average life occurring in 2002. Any 7 year window with acquisition or restructuring activity that changes options outstanding by ±20% was completely removed since the structure of the firm was significantly altered and past behavior may not be representative.

B. ESO Exercise Behavior and Expected Life Benchmark

The first row of Panel A of Table 2 presents descriptive statistics for $Life_{Hist}$. As a point of reference, Huddart and Lang (1996) calculate the average holding term conditional on exercise, meaning options expired out of the money, forfeited, and canceled are not included. Their results for the 10th percentile, median, and 90th percentile are 1.14, 3.00, and 6.04 years respectively while mine are 2.30, 4.12, and 6.00 years. Carpenter (1998), based on observation of executives of 40 firms and conditional upon exercise, finds a mean of 5.83 years with a standard deviation of 2.25 years while my mean is 4.15 years with a standard deviation of 1.43 years. The Huddart and Lang results are the more reasonable comparison. Executives have greater wealth than the general employee base and their exercises are public information, thus they hold their options longer on average than the common employee.

To further support this point and demonstrate the importance of a measurement of ESO life for all employees, I track each individual group of options for CEOs of 226 firms for the years 2006 thru 2009[5]. Table 3 shows the turnover of the CEO's portfolio (percent of all options held exercised during the fiscal year) is significantly less than that of all employees of the same firm. Even conditional upon CEO exercise of options the turnover is lower for CEOs. More importantly, when executives exercise their options, the life of the options is significantly higher than that of all employees of the same firm. Not reported in the table, the CEO's $Life_{Hist}$ is greater than all employees' $Life_{Hist}$ 80% of the time for the sample. These differences are important because the percentage of options granted to the top five executives for this sample is 29% with a standard deviation of 15% as reported in Panel A of Table 3.

[5] The statistics for all employees include the CEO as well, so differences between the CEO and all employees other than the CEO are understated.

Table 2

Factors Affecting ESO Life

The descriptive statistics for the sample are provided in Panel A. Only seven year measurement periods are shown since five year measurement periods are very similar. Panel B reports the historical life of option observation count per industry. Panel C states the number of firm-year observations of historical life of options per firm. Panel D presents regressions results for formulation of the life benchmarks $\widehat{Life}_{Hist}$ and $\widehat{Life}_{10K}$. $Life_{Hist}$ is the average of all options terminated during the prior seven years. $Life_{10K}$ is the reported expected life in the 10-K. $Life_{Overhang}$ is age of the outstanding options at of the end of the fiscal year. $Life_{10K,Ind}$ is the Fama-French 30 median industry reported expected life. *PctTop5* is the number of options granted to the top five employees divided by the total number of options granted for the fiscal year. *Vest* is the average vesting time for all options granted. Vol_{Hist}, Vol_{Mkt}, and Vol_{Sales} are the standard deviation of stock returns, market returns, and quarterly firm sales respectively for the previous five years. *Ret* is the stock price return for the prior five years. *MaxRet* is the maximum monthly return during the prior five years. *Treas7yr* is the implied return on a seven year government bond. *CAPMBeta* is the market model beta for the prior five years. *DivYield* is the dividends declared divided by the average stock price over the prior year. *TotAsst* is the total assets in millions. *Salesgrowth* is the percentage change in sales from the previous year. *M/B* is the market to book ratio. *D/E* is total debt divided by market equity. *ROA* is operating income divided by total assets. *R&D* is research and development expense divided by total assets. *HH* is the Herfindahl index as a measure of industry concentration at the three digit SIC code level. All variables with a bar above them are averaged over the previous seven and five years for regressions 1 and 2 respectively. Only five year averages are shown in Panel A. All tests control for industry fixed effects defined by Fama-French 30 industry definitions. Errors are clustered at the firm level and t-statistics are reported in parentheses. Panel E provides descriptive statistics for all four benchmarks, the differences between the benchmarks, and the difference between volatility as stated in the 10-K and the benchmark. $Life_{Hist10K}$ is the average of reported 10-K life for the previous five years.

Panel A: Descriptive Statistics for Sample

				Percentile				
	N	Mean	Std Dev	10th	25th	50th	75th	90th
$Life_{Hist}$	3,453	4.15	1.43	2.30	3.11	4.12	5.18	6.00
$Life_{10K}$	2,946	5.53	1.33	4.00	4.80	5.30	6.30	7.00
$Life_{Overhang}$	3,453	1.14	0.88	0.26	0.62	1.06	1.56	2.25
$Life_{10K,Ind}$	3,272	5.38	0.47	5.00	5.00	5.25	5.80	6.00
$\overline{PctTop5}$	3,447	0.29	0.15	0.11	0.19	0.27	0.38	0.49
$Vest$	3,438	2.25	0.81	1.33	1.81	2.13	2.54	3.00
Vol_{Hist}	3,374	0.43	0.23	0.19	0.26	0.37	0.55	0.77
Vol_{Mkt}	3,427	0.15	0.03	0.09	0.13	0.16	0.18	0.19
Vol_{Sales}	3,438	0.04	0.04	0.00	0.01	0.03	0.05	0.09
$\overline{Ret}$	3,385	0.98	1.99	-0.56	-0.13	0.43	1.31	2.90
$\overline{MaxRet}$	3,386	0.41	0.34	0.14	0.19	0.30	0.50	0.79
$\overline{Treas7yr}$	3,441	0.04	0.01	0.02	0.04	0.04	0.04	0.05
$CAPMBeta$	3,380	1.17	0.86	0.26	0.57	0.99	1.58	2.27
$\overline{DivYield}$	3,442	0.01	0.02	0.00	0.00	0.00	0.02	0.04
$\overline{TotAssts}$	3,447	6,595.82	16,454.90	153.69	437.60	1,370.77	4,155.36	15,550.40
$\overline{SalesGrowth}$	3,444	0.17	0.41	-0.01	0.04	0.09	0.18	0.32
$\overline{M/B}$	3,453	2.57	2.28	0.01	1.19	1.93	3.31	5.48
$\overline{D/E}$	3,405	0.52	0.97	0.00	0.05	0.21	0.57	1.28
$\overline{ROA}$	3,447	0.00	0.16	-0.12	0.00	0.03	0.07	0.11
$\overline{R\&D}$	3,447	0.05	0.09	0.00	0.00	0.00	0.05	0.15
$\overline{HH}$	3,429	0.15	0.14	0.05	0.06	0.10	0.18	0.31

(Continued)

Table 2-*Continued*

Panel B: Frequency of $Life_{Hist}$ observations by Industry

Fama-French 30 Industry	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Frequency	63	19	8	38	43	49	53	408	131	6	84	62	133	72	50
Fama-French 30 Industry	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Frequency	34	9	5	97	121	76	354	330	80	89	92	236	52	512	6

Panel C: $Life_{Hist}$ Firm-Year Observation Count by Firm

Firm-Years	Number of Firms
1	70
2	71
3	85
4	102
5	83
6	106
7	195

(Continued)

Table 2-*Continued*

Panel D: Regression results for Life benchmark

	$Life_{Hist}$ (1)	$Life_{10K}$ (2)
Intercept	8.73 (6.74)	1.25 (1.5)
$Life_{Hist}$		0.33 (14.03)
$Life_{Overhang}$		0.17 (4.69)
$Life_{10K,Ind}$		0.69 (8.93)
$\overline{PctTop5}$	1.05 (3.12)	0.18 (1.00)
$Vest$	0.12 (2.38)	0.15 (5.23)
$\overline{Vol_{Hist}}(1),\ Vol_{Hist}(2)$	-3.79 (-6.61)	-0.3 (-1.06)
$\overline{Vol_{Mkt}}(1),\ Vol_{Mkt}(2)$	-3.55 (-1.59)	2.67 (2.98)
$\overline{Vol_{Sales}}(1),\ Vol_{Sales}(2)$	-0.63 (-1.18)	-0.04 (-0.07)
$\overline{Ret5}(1), Ret5(2)$	-0.04 (-1.25)	0 (-0.34)
$\overline{MaxRet5}(1), MaxRet5(2)$	0.74 (2.71)	-0.06 (-0.48)
$\overline{Treas7yr}$ (1), $Treas7yr(2)$	-47.71 (-7.92)	6.64 (2.27)
$\overline{CAPMBeta}$ (1), $CAPMBeta$ (2)	0.03 (0.29)	-0.03 (-0.61)
$\overline{DivYield}$	-12.49 (-3.72)	5.53 (3.14)
$\overline{\ln(TotAssts)}$	0.01 (0.29)	-0.11 (-5.36)
$\overline{\ln(SalesGrowth)}$	-0.12 (-0.48)	0 (0.03)
$\overline{M/B}$	0.06 (2.34)	0.01 (0.6)
$\overline{D/E}$	0.07 (1.07)	0.09 (2.69)
$\overline{ROA}$	0.63 (2.02)	-0.22 (-1.09)
$\overline{R\&D}$	0.8 (0.98)	-0.77 (-1.8)
$\overline{HH}$	-0.09 (-0.26)	0.26 (1.3)
N	3,312	2,692
Adjusted R-Squared	0.35	0.23

Table 3

Option Holdings of CEOs and All Employees

This table provides statistics for option turnover (options exercised during fiscal year divided by beginning of year outstanding options), the weighted average remaining life of options outstanding at the end of the fiscal year, and the weighted average life of options terminated (exercised, canceled, forfeited, or expired) during the fiscal year. For comparison of distribution, statistics are paired for each firm-year. The data cover 226 randomly chosen firms for the fiscal years 2006 to 2009.

		Percentile						
	N	10th	25th	50th	75th	90th	Wilcoxon Test Statistic	Wilcoxon P-value
All Turnover								
CEO	464	0%	0%	1%	14%	32%		
All	464	8%	11%	18%	26%	34%		
CEO – All (paired)	464	-26%	-18%	-11%	-4%	7%	-37789	<.0001
Turnover conditional on CEO exercise								
CEO	248	2%	6%	12%	25%	50%		
All	248	10%	13%	20%	29%	37%		
CEO – All (paired)	248	-18%	-13%	-6%	3%	18%	-5580	<.0001
Average Life of Options Terminated								
CEO	248	4.05	5.58	8.42	9.93	9.96		
All	248	2.58	4.61	5.79	7.20	8.58		
CEO – All (paired)	248	-1.06	0.38	1.86	3.67	4.98	11286	<.0001

Panel B of Table 2 provides an observation count for the Fama-French 30 industry definitions. While some industries are low in firm count, there is no need to remove any observations when utilizing industry fixed effects. Panel C provides the distribution of observation count per firm.

Prior research suggests many factor affect exercise behavior. Since they cover only 8 firms, the results from Huddart and Lang (1996) are not generalizable across firm characteristics, but they can provide insight into non-firm-specific factors. Their results show that prior returns, the ratio of market price to strike price, vesting, and pending forfeiture drive the percentage of options exercised any given point in time. The results get stronger the lower ranking the employee within the firm. Bettis et al (2005) utilize the Carpenter (1998) utility model and calibrate it utilizing insider filings. They present the expected term based on sample median values and the effect of increasing each value by 50%. The 50% increase in risk aversion, volatility, probability of leaving the firm, and outside wealth changes expected term by -16%, -25%, -4%, and 9% respectively. Based on insider filings, their regression results support that volatility, dividends, and unexpected returns decrease holding term while being the CEO increases it. This particular test provides good insight but replication for this study is not reasonable for several reasons. The data do not explicitly state the age of options when exercised but rather the time left to maturity. Also the data is observable only upon exercise so forfeiture and expiration are not observed. Additionally, Bettis et al show there are differences even within the pool of insiders based on rank in the organization.

The combination of the results of Huddart and Lang (1996), Carpenter (1998), and Bettis et al (2005) indicate the following variable might help explain variations in ESO holding terms: short-term return, long-term return, momentarily high market to strike price, prior volatility, forfeiture due to employment termination, fraction of options vested, risk aversion, outside wealth, dividend rate, and rank within firm. If $Life_{Hist}$ can be partially explained, firms may be able to formulate expectations for future ESO holding terms. I test the following model to explain past behavior:

$$Life_{Hist} = \beta_0 + \beta_1 PctTop5 + \beta_2 Vest + \beta_3 \overline{Vol_{Hist}} + \beta_4 \overline{Vol_{Mkt}} + \beta_5 \overline{Vol_{Sales}} + \beta_6 \overline{Ret5} + \beta_7 \overline{MaxRet5} + \beta_8 \overline{Treas7yr} + \beta_9\, CAPMBeta + \beta_{10} \overline{DivYield} + \beta_{11} \overline{ln\,(TotAssts)} + \beta_{12} \overline{ln\,(SalesGrowth)} + \beta_{13} \overline{M/B} + \beta_{14} \overline{D/E} + \beta_{15} \overline{ROA} + \beta_{16} \overline{R\&D} + \beta_{17} \overline{HH} + Industry\ Effects \quad (2)$$

PctTop5 is the portion of all option granted that are granted to the top five employees. *Vest* is the average time to vest for options granted (e.g. if the options vest equally at years 1 thru 4, the average vesting term would be 2.5 years). Vol_{Hist} is the annualized stock return standard deviation for the previous five years. Vol_{Mkt} is the stock return standard deviation for the Compustat universe for the previous five years. Vol_{Sales} is the standard deviation of quarterly sales deflated by total assets for the previous five years. *Ret5* is the stock price return for the prior five year period. *MaxRet5* is the maximum monthly return during the prior 5 years and serves as a proxy for the highest market to exercise price. *CAPMBeta* is the market model beta for the prior five years. *DivYield* is the dividends declared divided by the average stock price over the prior year. *TotAsst* is the total assets. *Salesgrowth* is the percentage change in sales. *M/B* is the market to book ratio. *D/E* is total debt divided by market equity. *ROA* is operating income divided by total assets. *Treas7yr* is the implied return on a seven year government bond. *R&D* is research and development expense divided by total assets. *HH is* Herfindahl index for the three digit SIC code industry based on sales. All variables with a bar above them are averaged over the previous seven years since the age of option exercised during a given year is the culmination of circumstances and events over the life of the option. Seven years accounts for the life of most options. Industry fixed effects are defined by Fama-French 30 industry definitions. Industry effects are intended to proxy primarily for forfeiture rates.

The descriptive statistics for the sample are given by Panel A of Table 2. The first regression of Panel D of Table 2 shows the results of the estimation of equation 2. I find long run volatility, percentage of options granted to executives, vesting schedule, peak returns, risk-free rate, dividend yield, market to book, return on assets, and industry have the greatest impact on exercise behavior based on the model specification of this paper. Volatility, risk-free rate, and dividend yield have negative relationships with average holding life while percentage of options granted to executives, vesting schedule, peak returns, market to book, and return on assets have positive relationships. In this model, realized volatility has a standardized coefficient of -0.64 and appears to be the primary driver. The addition of industry effects increases the adjusted R-squared from .28 to .35 which I believe reflects the importance of turnover and forfeiture not captured by the model.

An important result of this model is the explanatory power of the model is significantly stronger than the explanatory power of a similar test performed by Bettis et al (2005). Their regression to explain contractual years remaining at exercise has qualitatively similar results but the R-squared of their model is 0.07 compared 0.35 for this model. Huddart and Lang (1996) found volatility had a much stronger impact for individual lower in the firm. If these results are generalizable, then a study on executives only may miss important characteristics affecting exercise.

The inclusion of industry effects provides good explanatory power for the model but has the potential to weaken the economic explanation of the rest of the model. To better understand the economics behind ESO exercise, I estimate equation 2 without the industry effects. The results are quite informative. All significant estimates from the model with industry fixed effects remain significant with no major change to the coefficient. For the newly significant variables, sales volatility has a negative coefficient (t-statistic -2.41) and the Herfindahl index has a positive coefficient (t-statistic 1.84). Higher values of the Herfindahl index indicate higher industry concentration. It is quite possible that fewer firms in an industry provide fewer opportunities for employees to switch employers. This would cause forfeiture rates to decrease and provide a positive influence on the life of the options.

The measurement window for historical life of ESOs was arbitrarily set at seven years. A longer window provides more data for each measurement but also reduces the number of usable observations for estimation of equation 2. Utilizing a five year window for the same estimation increases observation count from 3,312 to 7,045, but adjusted R-squared drops from 0.35 to 0.21. A few estimates change in significance as well. Market volatility is negative (t-statistic -3.47), the log of sales growth is negative (t-statistic -1.86), and ROA loses some significance (t-statistic 1.72).

The guidance by SFAS-123 instructs firms to consider their average historical ESO life when estimating expected life for new options granted. To better understand the factors firms consider when estimating expected life, I estimate the following equation:

$$\begin{aligned} Life_{10K} = {} & \beta_0 + \beta_1 Life_{Hist} + \beta_2 Life_{Overhang} + \beta_3 Life_{10K,Ind} \\ & + \beta_4 PctTop5 + \beta_5 Vest + \beta_6 Vol_{Hist} + \beta_7 Vol_{Mkt} \\ & + \beta_8 Vol_{Sales} + \beta_9 Ret5 + \beta_{10} MaxRet5 + \beta_{11} Treas7yr \\ & + \beta_{12}\, CAPMBeta + \beta_{13} \overline{DivYield} + \beta_{14} \overline{ln\,(TotAssts)} \\ & + \beta_{15} \overline{ln\,(SalesGrowth)} + \beta_{16} \overline{M/B} + \beta_{17} \overline{D/E} + \beta_{18} \overline{ROA} \\ & + \beta_{19} \overline{R\&D} + \beta_{20} \overline{HH} + Industry\ Effects \end{aligned} \tag{3}$$

The intention of this regression is to relate what each firm claims to what other firms claim while considering economic factors. The bar above a variable indicates a five year average which is used as an estimate for each value looking forward. $Life_{Overhang}$ is the age of the outstanding options as of the end of the fiscal year. $Life_{10K,Ind}$ is the Fama-French 30 median industry reported expected life. $\widehat{Vol}_{10K}$ is the volatility benchmark equivalent to this benchmark as described in Appendix B. All other variables have been described previously with the only differences being *Ret5* and *MaxRet5* are measured over the previous five years. The second regression of Panel D of Table 2 shows the estimation results. It appears firms consider their prior exercise history as the coefficient is 0.33. Interestingly, the coefficient on the age of the options still outstanding is 0.17, so the option overhang factors into the estimate as well. These are important results that demonstrates firms consider their own exercise history. The strong positive relationship with the industry median reported value also indicates that firms are somewhat aligned on their assumptions. When reported expected life is regressed against the same variables used with the historical life regression, there are some inconsistencies. The percent of options granted to executives and divided yield have no significance, historical market volatility and the treasury rate have the opposite sign, and firm size has a negative coefficient.

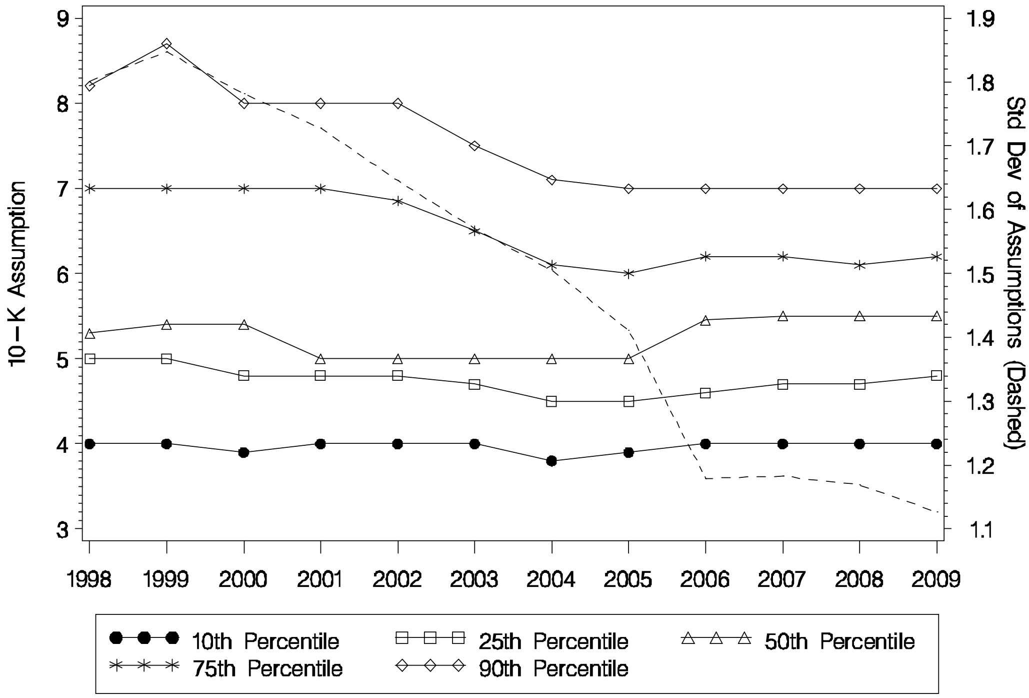
Unlike the estimation for historical life of ESO, removal of industry effects has very little impact on the estimation of equation 3. Nevertheless, removal of the industry median volatility assumption along with industry effects, to break the connection to industry, does decrease adjusted R-squared from 0.28 to 0.18. The new estimation still provides no additional significance to any estimates.

C. Benchmarks

The purpose of constructing benchmark values for expected life and volatility is to set a reasonable reference point and then measure how far from that point a firm deviates from the reference for any given firm-year. I start first with an analysis of the reported ESO valuation assumptions in the 10-K. Figure 3 shows the reported assumptions over time. Expected Volatility and Expected Life both appear to be somewhat stable over time in the middle and lower percentiles while the upper percentiles have dropped over time. The standard deviation of reported values has also dropped over time. The trends suggest that models assumptions stabilized around the time that pro-forma stock option expense became a true expense in the income statement. Panels A and B of Table 4 provide the descriptive statistics for the sample and correlations between the assumptions. Panel C relates expected life to all of the assumptions simultaneously. Assumptions appear to follow theory in terms of the relationship between expected life and expected volatility. Oddly enough, the expected dividend yield has a positive relationship with expected life.

I construct four benchmarks for expected life. The first, $Life_{Hist}$, is the historical estimate constructed in Section 3. The second, $\widehat{Life}_{Hist}$, is the fitted value from the estimation of Equation 2. The third benchmark, $Life_{Hist10K}$, is the average of the reported expected life for the previous five years. I require a minimum of three observations to form this benchmark. The fourth benchmark, $\widehat{Life}_{10K}$, is the is the fitted value of equation 3. I construct four similar benchmarks for volatility which are detailed in Appendix B.

Panel A: 10-K Life



Panel B: 10-K Volatility

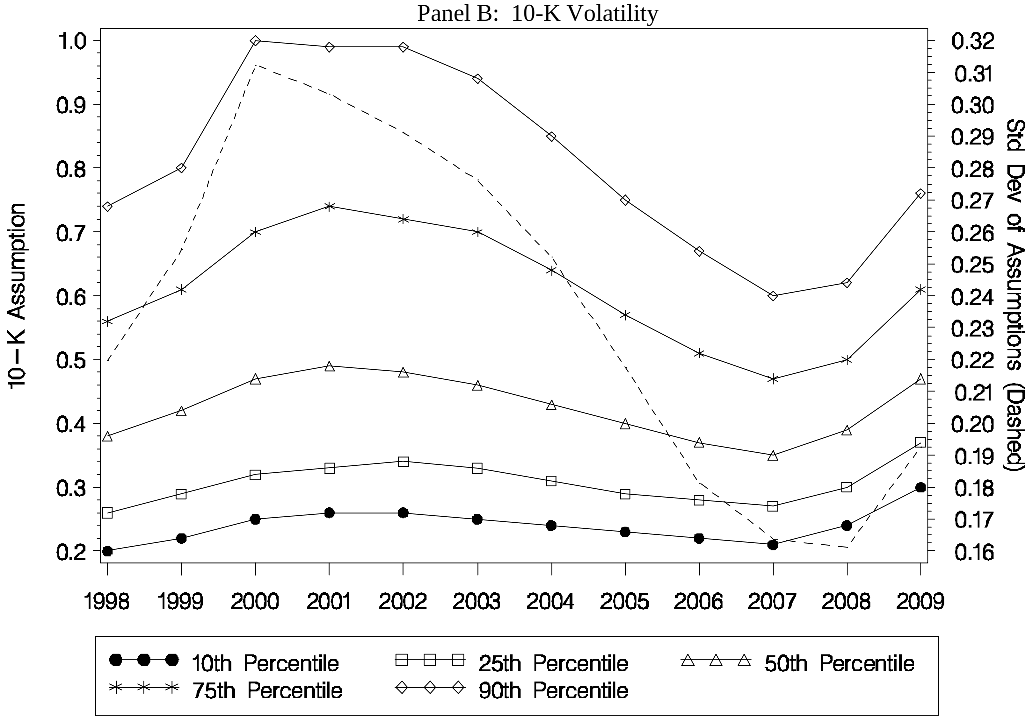
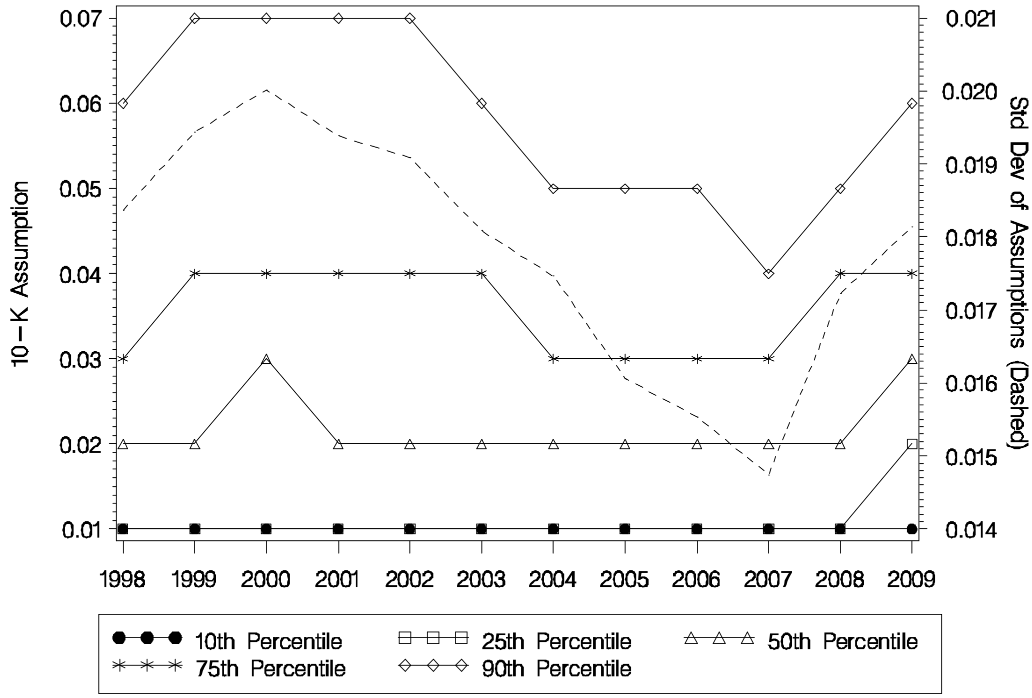


Figure 3. 10-K Valuation Assumptions. The graphs provide various percentiles of stated assumptions over time. Volatility of assumptions depicts the dispersion among firms for a given year. Panel C is based only on non-zero dividend assumptions thus representing a portion of the available data. Panel D shows the percentage of dividend assumptions that are non-zero.

Panel C: 10-K Dividend



Panel D: Percent of All Expected Divdends that are Non-zero

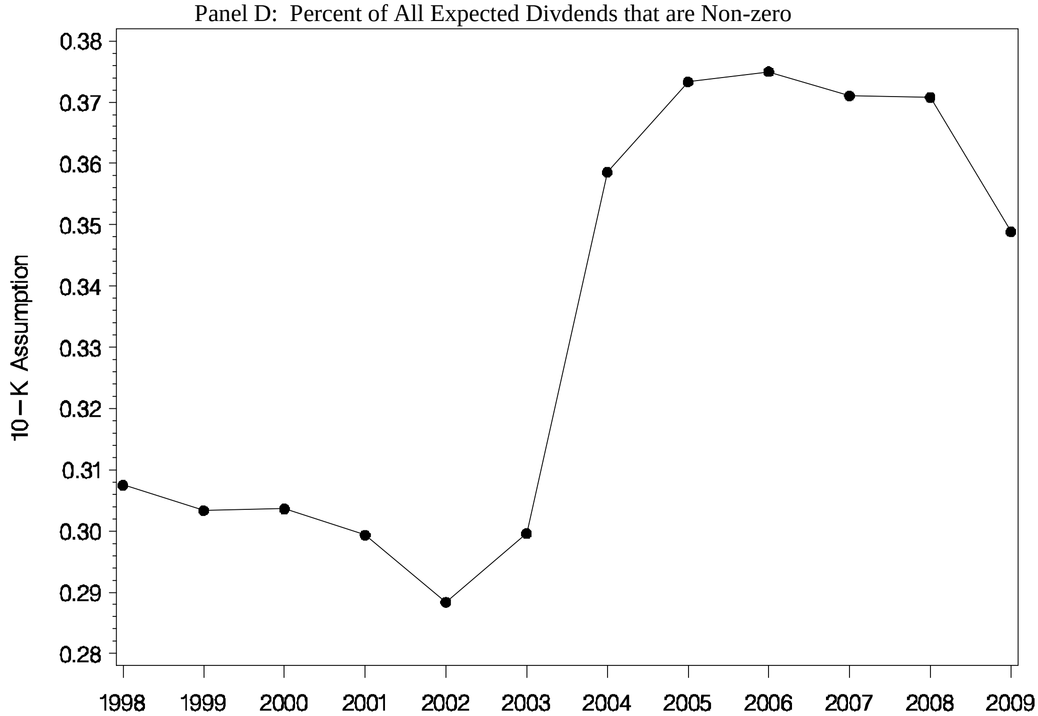


Figure 3-*Continued*

Table 4

Analysis of 10-K Assumptions

Panel A presents the descriptive statistics of the valuation assumptions presented in the 10-K per SFAS 123(R). Panel B provides correlations among the assumptions. The lower left portion of the table presents the Pearson correlations, and the upper right half presents the Spearman correlations. The four variables analyzed are the valuation assumptions as stated in the 10-K. Expected Life is filtered on likely 10-year grants. The data covers 1,180 firms from 1998 to 2008. The p-value to test the hypothesis that the correlation is equal to zero is in parentheses. Panel C provides regression results where Expected Life is the dependent variable and the remaining assumptions are the independent variables. All variables are Winsorized at the 1st and 99th percentiles. T-statistics for standard errors are reported in parentheses.

Panel A: Descriptive Statistics

Variable	N	Mean	Std Dev	Percentile				
				10th	25th	50th	75th	90th
Volatility	26,361	0.48	0.25	0.23	0.30	0.41	0.60	0.80
Life	14,511	5.61	1.55	4.00	4.70	5.30	6.50	7.50
Div Yield	31,599	0.01	0.02	0.00	0.00	0.00	0.01	0.03
Risk-Free	26,693	0.04	0.01	0.03	0.03	0.04	0.05	0.06

Panel B: Correlations

	Volatility	Life	Div Yield	Risk-Free
Volatility	1.00	-0.24 (<.0001)	-0.63 (<.0001)	-0.09 (<.0001)
Life	-0.24 (<.0001)	1.00	0.25 (<.0001)	0.17 (<.0001)
Div Yield	-0.63 (<.0001)	0.25 (<.0001)	1.00	0.05 (<.0001)
Risk-Free	-0.09 (<.0001)	0.17 (<.0001)	0.05 (<.0001)	1.00

Panel C: Regression of Expected Life on 10-K Assumptions

Intercept	4.75 (80.49)
Volatility	-0.74 (-12.14)
Risk-Free	23.45 (21.89)
Div Yield	14.43 (17.84)
N	13,003
R-Squared	0.10

Panel A of Table 5 provides descriptive statistics for the life benchmarks and deviations of reported expected life from those benchmarks. The most notable statistic is that reported expected life is 1.54 years greater than the measurement for historical life. Panel B provides statistics for the volatility benchmarks and the deviations from the benchmarks. Disclosed values deviate from historical measures on average by -0.01 with a standard deviation of approximately 0.14. Expected volatility minus own historical reported volatility has a mean of -0.01 and a standard deviation of 0.11. Expected volatility deviates from benchmarks based on peer assumptions with a mean of 0.00 (by design) and a standard deviation of 0.12.

Panels A and B of Table 6 provide the correlations between the different benchmarks for both volatility and life. For life the correlations range from 0.58 to 0.73 when $Life_{Hist10K}$ is excluded. The correlations with $Life_{Hist10K}$ range from 0.29 to 0.51. $Life_{Hist10K}$, unlike the other benchmarks, has no direct connection to historical ESO holdings or economic factors. For volatility, the correlations range from 0.75 to 0.97 when $Vol_{Hist10K}$ is excluded. Correlations with $Vol_{Hist10K}$ range from 0.70 to 0.82. The results suggests all of the benchmarks are consistent with each other but provide unique information. Panel C shows the correlations of deviations from the benchmarks. Deviations from life benchmarks are highly correlated with deviations from other life benchmarks. The most surprising of those correlations are the strong positive correlations between deviations from the economic benchmarks and the deviation from own report history, ranging from 0.36 to 0.41. The same is true for volatility

Table 5

Benchmarks and Deviations from Benchmarks

This table provides descriptive statistics for four benchmarks for both expected life and expected volatility. $Life_{10K}$ is the reported expected life. $Life_{Hist}$ is the measure of historical life of ESOs held my all employees. $\widehat{Life}_{Hist}$ is the fitted value of historical ESO life against explanatory regressors. $Life_{Hist10K}$ is the average reported expected life for the previous five years. $\widehat{Life}_{10K}$ is the fitted value of expected life against explanatory regressors. Vol_{10K} is the reported expected volatility. Vol_{Hist} is stock price volatility for the prior five years. $\widehat{Vol}_{Hist}$ is the fitted value of historical volatility against explanatory regressors. $Vol_{Hist10K}$ is the average reported expected volatility for the previous five years. $\widehat{Vol}_{10K}$ is the fitted value of expected life against explanatory regressors.

Panel A: Life

	N	Mean	Std Dev	Percentile 10th	25th	50th	75th	90th
Benchmarks								
$Life_{Hist}$	3,442	4.15	1.43	2.30	3.11	4.12	5.18	6.00
$\widehat{Life}_{Hist}$	3,312	4.14	0.86	3.04	3.67	4.24	4.72	5.09
$Life_{Hist10K}$	12,108	5.63	1.43	4.00	4.73	5.40	6.40	7.40
$\widehat{Life}_{10K}$	2,728	5.52	0.63	4.77	5.09	5.49	5.92	6.38
Benchmark-Adjusted Life								
$Life_{10K} - Life_{Hist}$	2,946	1.40	1.58	-0.41	0.33	1.28	2.32	3.48
$Life_{10K} - \widehat{Life}_{Hist}$	2,831	1.41	1.37	-0.24	0.51	1.27	2.24	3.07
$Life_{10K} - Life_{Hist10K}$	11,257	-0.06	0.78	-0.92	-0.30	0.00	0.23	0.74
$Life_{10K} - \widehat{Life}_{10K}$	2,728	0.00	1.17	-1.32	-0.74	-0.07	0.65	1.44

Panel B: Volatility

	N	Mean	Std Dev	Percentile 10th	25th	50th	75th	90th
Benchmarks								
Vol_{Hist}	64,548	0.52	0.27	0.22	0.31	0.46	0.68	0.91
$\widehat{Vol}_{Hist}$	53,297	0.54	0.20	0.30	0.41	0.53	0.66	0.79
$Vol_{Hist10K}$	30,773	0.53	0.27	0.25	0.32	0.47	0.69	0.91
$\widehat{Vol}_{10K}$	27,762	0.50	0.21	0.26	0.34	0.46	0.63	0.80
Benchmark-Adjusted Volatility								
$Vol_{10K} - Vol_{Hist}$	30,627	0.00	0.15	-0.15	-0.05	0.00	0.06	0.13
$Vol_{10K} - \widehat{Vol}_{Hist}$	28,050	0.00	0.18	-0.19	-0.11	-0.02	0.09	0.20
$Vol_{10K} - Vol_{Hist10K}$	28,300	0.00	0.13	-0.14	-0.06	0.00	0.05	0.13
$Vol_{10K} - \widehat{Vol}_{10K}$	27,762	0.00	0.14	-0.13	-0.06	-0.01	0.05	0.13

Table 6

Correlation between Benchmark-Adjusted Life and Volatility Assumptions

The following tables provide the Pearson correlation among the life and volatility benchmarks and assumptions in the 10-K adjusted by the various benchmarks. The p-value to test the hypothesis that the correlation is equal to zero is in parentheses.

Panel A: Life Benchmarks

	$Life_{Hist}$	$\widehat{Life}_{Hist}$	$Life_{Hist10K}$	$\widehat{Life}_{10K}$
$Life_{Hist}$	1.00			
$\widehat{Life}_{Hist}$	0.60 (<0.01)	1.00		
$Life_{Hist10K}$	0.33 (<0.01)	0.29 (<0.01)	1.00	
$\widehat{Life}_{10K}$	0.73 (<0.01)	0.58 (<0.01)	0.51 (<0.01)	1.00

Panel B: Volatility Benchmarks

	Vol_{Hist}	$\widehat{Vol}_{Hist}$	$Vol_{Hist10K}$	$\widehat{Vol}_{10K}$
Vol_{Hist}	1.00			
$\widehat{Vol}_{Hist}$	0.75 (<0.01)	1.00		
$Vol_{Hist10K}$	0.79 (<0.01)	0.70 (<0.01)	1.00	
$\widehat{Vol}_{10K}$	0.97 (<0.01)	0.84 (<0.01)	0.82 (<0.01)	1.00

(Continued)

Table 6-*Continued*

Panel C: Interaction between Volatility and Life Benchmarks

	$Vol_{10K} - Vol_{Hist}$	$Vol_{10K} - \widehat{Vol}_{Hist}$	$Vol_{10K} - Vol_{Hist10K}$	$Vol_{10K} - \widehat{Vol}_{10K}$	$Life_{10K} - Life_{Hist}$	$Life_{10K} - \widehat{Life}_{Hist}$	$Life_{10K} - Life_{Hist10K}$	$Life_{10K} - \widehat{Life}_{10K}$
$Vol_{10K} - Vol_{Hist}$	1.00							
$Vol_{10K} - \widehat{Vol}_{Hist}$	0.50 (<0.01)	1.00						
$Vol_{10K} - Vol_{Hist10K}$	0.36 (<0.01)	0.39 (<0.01)	1.00					
$Vol_{10K} - \widehat{Vol}_{10K}$	0.90 (<0.01)	0.76 (<0.01)	0.41 (<0.01)	1.00				
$Life_{10K} - Life_{Hist}$	-0.01 0.44	0.11 (<0.01)	-0.02 (0.25)	0.07 (<0.01)	1.00			
$Life_{10K} - \widehat{Life}_{Hist}$	-0.02 (0.20)	0.12 (<0.01)	0.01 (0.66)	0.07 (<0.01)	0.73 (<0.01)	1.00		
$Life_{10K} - Life_{Hist10K}$	0.01 (0.22)	0.00 (0.82)	0.00 (0.62)	0.00 (0.84)	0.25 (<0.01)	0.31 (<0.01)	1.00	
$Life_{10K} - \widehat{Life}_{10K}$	0.06 (<0.01)	0.06 (<0.01)	0.06 (<0.01)	0.07 (<0.01)	0.75 (<0.01)	0.85 (<0.01)	0.37 (<0.01)	1.00

benchmarks with correlations to deviations from own history ranging from 0.25 to 0.37. Thus a departure from the historical and economic benchmarks is often a departure from own history in the same direction. Finally, Panel C also shows that deviations from volatility benchmarks are mostly positively related to deviations from life benchmarks but with low values. This is potentially a strong result in the sense that theory would suggest that deviations should be negatively correlated if the assumptions make economic sense. The lack of a negative correlation indicates either intentional manipulation of values or irrational expectations of the future.

Deviating from "true" values for the model assumptions creates variability in reported value of options granted and consequently earnings, pro-forma before

SFAS 123(R) and directly after SFAS 123(R). Table 7 quantifies the impact of deviations from benchmark values on FMV and earnings per share. The baseline value is the FMV based on benchmark values and the change is the FMV calculated from reported values minus the benchmark FMV. Panel A shows the interquartile spread (value for 75th percentile less value for the 25th percentile) in percent change in FMV ranges from 18% to 37% for the various benchmarks. The change in earnings per share has an interquartile spread that ranges from 1.7 cents to 3.4 cents per share and extends to 7.8 cents per share on average between the 10th and 90th percentile values.

Table 7

Deviation from Benchmark Sensitivity

This table demonstrates the change in Fair Market Value (FMV) and Earnings Per Share (EPS) in dollars where the baseline case is the Black-Scholes value calculated from the benchmark values and the deviation is based on the Black-Scholes value using the assumptions in the 10-K. I assume all options granted during the fiscal year are expensed immediately.

Panel A: Percent Change in FMV

Assumptions	N	Mean	Std Dev	Percentile				
				10th	25th	50th	75th	90th
$Life_{Hist}, Vol_{Hist}$	2,791	12%	23%	-14%	1%	14%	27%	36%
$\widehat{Life}_{Hist}, \widehat{Vol}_{Hist}$	2,682	4%	34%	-36%	-11%	10%	26%	39%
$Life_{Hist10K}, Vol_{Hist10K}$	10,478	-3%	18%	-25%	-11%	0%	7%	15%
$\widehat{Life}_{10K}, \widehat{Vol}_{10K}$	2,587	-3%	23%	-28%	-13%	0%	10%	19%

Panel B: Change in EPS

Assumptions	N	Mean	Std Dev	Percentile				
				10th	25th	50th	75th	90th
$Life_{Hist}, Vol_{Hist}$	2,755	-0.030	0.550	-0.073	-0.034	-0.010	0.000	0.010
$\widehat{Life}_{Hist}, \widehat{Vol}_{Hist}$	2,678	-0.010	0.580	-0.066	-0.026	-0.005	0.007	0.039
$Life_{Hist10K}, Vol_{Hist10K}$	10,225	0.000	0.500	-0.025	-0.007	0.000	0.010	0.036
$\widehat{Life}_{10K}, \widehat{Vol}_{10K}$	2,587	0.010	0.600	-0.028	-0.009	0.000	0.010	0.034

D. Incentives to Manipulate Reported ESO Expense

The previous section demonstrates that deviations from benchmark values have a significant impact on reported ESO expense and earnings. The slightly positive correlation (and hence a lack of negative correlation) between deviations from life benchmarks and volatility benchmarks suggests manipulation of values or irrational expectations of the future. This section tests for possible incentives to manipulate the assumptions and the subsequent effect of deviations on volatility and cumulative abnormal returns. Unlike traditional earnings management where managers shift profits across time, when FMV of options is underreported, there is no truing up at any point. Thus the effect is permanent and the temptation in certain circumstances can be high. I test for manipulation where incentives are high. Since manipulation of earnings carries risk of punishment, I also test the responsiveness of option price to changes in the assumptions. I estimate the following logistic equations:

$$\begin{aligned}&\text{logit}[\Pr(LifeQ1 = 1)\\&= \beta_0 + \beta_1 CAR\_PriorYear + \beta_2\, Return1Yr\\&+ \beta_3 NegIncome + \beta_4\, Accrual + \beta_5\, OptionsOutstanding\\&+ \beta_6 Ln(TotAssts) + \beta_7\, dEPS\_dLife + \beta_8 Theta\end{aligned} \tag{4}$$

$$\begin{aligned}&\text{logit}[\Pr(VolQ1 = 1)\\&= \beta_0 + \beta_1 CAR\_PriorYear + \beta_2\, Return1Yr\\&+ \beta_3 NegIncome + \beta_4\, Accrual + \beta_5\, OptionsOutstanding\\&+ \beta_6 Ln(TotAssts) + \beta_7\, dEPS\_dVol + \beta_8 Vega\end{aligned} \tag{5}$$

LifeQ1 and *VolQ1* are dummy variable equal to one if the deviation from benchmarks for life and volatility respectively rank in the lowest quartile (hence the strongest deviation downwards). The variables equal 0 if the respective deviations are in the top half of the distribution. I choose a Logit model because there really isn't any theory to explain why firms would overestimate their assumption. Thus I would not expect the specified relationship to fit the data for observations that overestimate assumptions. I also remove the second quartile of data because it is not clear if that group is just part of the distribution about the mean or a group of firms that is possibly manipulating the assumptions.

CAR_PriorYear is the cumulative monthly abnormal returns based on the market model for the fiscal year. *Return1Yr* is the stock return for the fiscal year. I predict a positive coefficient for both return measures since managers of firms with negative returns, either absolute or relative to expectations, may be motivated to underreport to disguise compensation and improve the appearance of earnings. *NegIncome* is a dummy variable for negative net income. I predict a positive coefficient since managers can reduce the losses through ESO expense manipulation. *Accrual* is the accounting accruals as defined by Subramanyam (1996). I predict a positive estimate since firms looking to improve accounting figures may use both paths to do so. *OptionsOutstanding* is the number of options outstanding at the end of the year deflated by the number of shares outstanding and serves as a proxy for motivation to disguise ESO expense due to the relative size of the stock option program. Thus I predict a negative coefficient. *ln(TotAssts)* is the natural log of total assets at the end of the fiscal year. *Vega* is the derivative of the value of the options granted with respect to the volatility of the underlying stock. I predict a negative coefficient for *Vega* since the responsiveness of manipulating determines the effect on FMV for a given amount of deviation. I define *Theta* as the derivative of the value of the options granted with respect to the expected life of the option.[6] All derivatives of option value are evaluated based on benchmark values of both life and volatility while risk-free rate and dividend yield are the assumptions reported in the 10-K. The variables *dEPS_dVol* and *dEPS_dLife* are the derivative of EPS with respect to volatility and life respectively. I predict positive coefficients for both variables as these variables represent the ability to impact the bottom line.

Table 8 provides estimation results for equations 4 and 5. Most of the results are quite mixed between different benchmarks for the same measure. It's possible that a mechanical relationship exists that is not being picked up by the model. Additionally, with the true effect on stock price undetermined, it could be that the expensing practices of a firm affect the explanatory variables. For example, the return regressors suggest that profitable firms are more likely to understate stock options expense. Nevertheless, it could be the case that these firms have influenced their returns by the practice of understating stock option expense. Despite these possibilities, the tests for incentives to manipulate ESO expense in

[6] The Greek letter Theta is often used to describe the derivative of the option value with respect to the time of the life of the option that has passed. In this case Theta has the same value but with the opposite sign since 0 years have elapsed at the time of grant.

Table 8

Factors Affecting Deviations from Benchmarks

The following tables provide logistic regression results for factors affecting the likelihood of deviations of model assumptions from benchmark values. $Life_{10K}$ and Vol_{10K} are the expected life and volatility assumptions in the 10-K respectively. The benchmarks are defined in Tables 3 and 5. *CAR_PriorYear* is the cumulative monthly abnormal returns based on the market model for the fiscal year. *Return1Yr* is the stock return for the fiscal year. *NegIncome* is a dummy variable for negative net income. *Accrual* is the accounting accruals as defined by Subramanyam (1996). *OptionsOutstanding* is the number of options outstanding at the end of the year deflated by the number of shares outstanding. *ln(TotAssts)* is the natural log of total assets at the end of the fiscal year. *Vega* is the derivative of the value of the options granted with respect to the volatility of the underlying stock. *Theta* is the derivative of the value of the options granted with respect to the remaining life of the option. All derivatives of option value are evaluated based on benchmark values of the expected life and volatility and the reported values of the risk-free rate and dividend yield as stated in the 10-K. *dEPS_dVol* and *dEPS_dLife* are the number of options granted divided by shares outstanding multiplied by *Vega* and *Theta* respectively. All variables are Winsorized at the 1st and 99th percentiles. All units are in 1000's for presentation of coefficients. Errors are clustered at the firm level and p-values are reported in parentheses.

Panel A: Expected Life

	Predicted Sign	Dependent Variables			
		$Life_{10K} - Life_{Hist}$ (1)	$Life_{10K} - \widehat{Life}_{Hist}$ (2)	$Life_{10K} - Life_{Hist10K}$ (3)	$Life_{10K} - \widehat{Life}_{10K}$ (4)
Intercept		-3.09 (<0.01)	-3.88 (<0.01)	0.94 (0.02)	1.06 (0.17)
CAR_PriorYear	-	-0.1 (0.41)	-0.05 (0.67)	-0.11 (0.08)	-0.05 (0.65)
Return1Yr	-	-0.18 (0.18)	-0.33 (0.02)	0.05 (0.46)	-0.01 (0.95)
NegIncome	+	-0.53 (<0.01)	-0.65 (<0.01)	-0.01 (0.95)	-0.24 (0.1)
Accrual	+	-23241.3 (0.58)	-80230.8 (0.02)	-23250.5 (0.23)	-49044.5 (0.12)
OptionsOutstanding	+	-1.16 (0.33)	-0.69 (0.56)	-3.84 (<0.01)	0.04 (0.97)
Ln(TotAssts)	?	0.14 (<0.01)	0.15 (<0.01)	-0.08 (<0.01)	-0.08 (0.02)
dEPS_dLife	+	10.84 (0.01)	2.63 (0.42)	-3.02 (0.04)	-4.95 (0.11)
Theta	+	-0.25 (0.01)	0.28 (<0.01)	0.23 (<0.01)	-0.1 (0.32)
N		1,797	1,782	6,860	1,732
Pseudo R-Squared		.08	.08	.02	.01

(Continued)

Table 8-*Continued*

Panel B: Volatility

	Predicted Sign	Dependent Variables: $Vol_{10K} - Vol_{Hist}$ (1)	$Vol_{10K} - \widehat{Vol}_{Hist}$ (2)	$Vol_{10K} - Vol_{Hist10K}$ (3)	$Vol_{10K} - \widehat{Vol}_{10K}$ (4)
Intercept		-2.57 (<0.01)	7.31 (<0.01)	4.41 (<0.01)	4.44 (<0.01)
CAR_PriorYear	-	0.96 (<0.01)	-0.86 (<0.01)	0.45 (<0.01)	0.24 (<0.01)
Return1Yr	-	-0.62 (<0.01)	0.33 (<0.01)	-0.51 (<0.01)	-0.39 (<0.01)
NegIncome	+	0.35 (<0.01)	-0.47 (<0.01)	-0.55 (<0.01)	0.01 (0.92)
Accrual	+	18690.68 (0.17)	15111.07 (0.34)	-13591.8 (0.3)	23637.51 (0.08)
OptionsOutstanding	+	0.49 (0.23)	0.58 (0.21)	4.78 (<0.01)	-2.42 (<0.01)
Ln(TotAssts)	?	0.09 (<0.01)	-0.42 (<0.01)	-0.26 (<0.01)	-0.25 (<0.01)
dEPS_dVol	+	-0.47 (<0.01)	-0.51 (<0.01)	0.8 (<0.01)	-0.68 (<0.01)
Vega	+	-0.03 (<0.01)	0.04 (<0.01)	0.02 (<0.01)	0.01 (0.14)
N		11,638	11,129	9,712	11,095
Pseudo R-Squared		.14	.17	.10	.06

this dissertation are very similar to those claiming to find a causal relationship, yet the results of this dissertation yield no such results.

E. Effect of Deviations on Subsequent Stock Price

I propose there are at least two channels through which stock options expense may impact firm valuation. The more obvious channel is through reported earnings. Nevertheless, the stated assumptions may also influence the investor valuing the liability of all outstanding options plus the implications of the delta and vega of the outstanding options. Probably the most interesting research question with respect to this topic is whether or not investors create their own assumptions for stock option valuation (perhaps in a fashion similar to the benchmarks in this dissertation) or if they take the stock option expense at face value. This question is very difficult to answer. Nevertheless, I hypothesize that noisy reporting of stock option assumptions leads to additional volatility beyond expected levels. I test this hypothesis by estimating the following equation:

$$VolResid = \beta_0 + \beta_1\, LifeNoise + \beta_2\, VolNoise + \beta_3 LifeNoise^2 + \beta_4\, VolNoise^2 + Industry\ Effects \tag{6}$$

VolResid is the residual of the estimation of equation B1 for the two year period following the end of the fiscal year based on daily data. Equation B1 fits the firm's actual volatility to factors explaining volatility. Thus the residual of that estimation is the difference of the actual volatility and the expected volatility. *LifeNoise* is the absolute value of $Life_{10K} - Life_{Hist}$, $Life_{10K} - \widehat{Life}_{Hist}$, $Life_{10K} - Life_{Hist10K}$, and $Life_{10K} - \widehat{Life}_{10K}$ for regressions 1 thru 4 respectively. $VolNoise$ is the absolute value of $Vol_{10K} - Vol_{Hist}$, $Vol_{10K} - VolHist$, $Vol10K{-}VolHist10K$, and $Vol10K{-}Vol10K$ for regressions 1 thru 4 respectively. Industry effects are defined per the Fama-French 30 definitions.

The four estimations of Equation 6 are shown in Panel A of Table 9. Regressions 1, 2, and 4 support the hypothesis that noise in stock option expense assumptions leads to greater noise in stock price in the subsequent years. Interestingly, the effect is attenuated with larger values of noise.

Another measure of price discovery that may be useful in this analysis is the cumulative abnormal return following the release of the 10-K. The ex-post returns could follow several patterns depending upon the theory of events. If investors take the assumptions at face value the cumulative abnormal returns could be negatively related deviations in assumptions. If investors eventually see through deviations or even elect punish a firm for underestimating ESO expense, cumulative abnormal returns could be positively related to deviations. Panel B of Table 9 shows there are significant relationships with CARs. Nevertheless, with predictive theory unable to pinpoint the likely outcome, the most conservative conclusion is that there is some effect on subsequent stock price due to deviations in assumptions.

Table 9

Effect of Reporting Variability on Subsequent Volatility and Returns

The following table provides regression results for subsequent stock price volatility and cumulative abnormal returns as a function of the deviations from the benchmark values of expected life and expected volatility. The dependent variable in Panel A is the residual of the predicted volatility based on a regression similar to regression 1 of Table 5, Panel B. The measurement period for subsequent volatility is one year beginning one month after the end of the fiscal year. The dependent variable in Panel B is the cumulative abnormal monthly return based on the market model for the same period of time. *LifeDev* is the absolute value of $Life_{10K} - Life_{Hist}$, $Life_{10K} - \widehat{Life}_{Hist}$, $Life_{10K} - Life_{Hist10K}$, $Life_{10K} - \widehat{Life}_{10K}$ for regressions 1 thru 4 respectively. $VolNoise$ is the absolute value of $Vol_{10K} - Vol_{Hist}$, $Vol_{10K} - \widehat{Vol}_{Hist}$, $Vol_{10K} - VolHist10K$, $Vol10K - Vol10K$ for regressions 1 thru 4 respectively. *LifeDev and VolDev* are defined the same as *LifeNoise* and *VolNoise* but are merely the difference without taking the absolute value. $SignedLifeDev^2$ and $SignedVolDev^2$ are the squared valued of *LifeDev and VolDev* with the original sign applied to the squared value. The coefficients on the life measures are multiplied by 1000 to show the precise value. All tests control for industry fixed effects defined by Fama-French 30 industry definitions. All variables are Winsorized at the 1st and 99th percentiles. Errors are clustered at the firm level and t-statistics are reported in parentheses.

Panel A: Subsequent Residual Volatility

	(1)	(2)	(3)	(4)
Intercept	0.21 (1.98)	0.21 (1.91)	0.01 (0.29)	0.22 (2.2)
LifeNoise	15.5 (2.37)	9.3 (1.17)	-1.6 (-0.19)	2.47 (0.2)
VolNoise	0.16 (1.48)	0.25 (2.77)	0.03 (0.39)	0.31 (2.55)
$LifeNoise^2$	-2.26 (-1.85)	-1.82 (-1.23)	2.08 (0.54)	-0.25 (-0.07)
$VolNoise^2$	-0.69 (-2.65)	-0.48 (-2.28)	-0.47 (-1.95)	-1 (-2.7)
N	2,639	2,631	8,851	2,526
R-Squared	0.04	0.04	0.01	0.04

Panel B: Subsequent Cumulative Abnormal Returns

	(1)	(2)	(3)	(4)
Intercept	-0.14 (-1.22)	-0.22 (-2.39)	0.11 (1.08)	-0.09 (-0.72)
LifeDev	34.56 (2.13)	9.53 (0.55)	-6.27 (-0.29)	-8 (-0.34)
VolDev	-1.45 (-5.98)	1.03 (6.52)	0.82 (5.24)	-0.2 (-0.76)
$SignedLifeDev^2$	-1.1 (-0.32)	4.01 (0.97)	13.45 (1.13)	7.54 (0.78)
$SignedVolDev^2$	2 (2.35)	0 (0.01)	-2.08 (-3.34)	1.02 (0.87)
N	2,639	2,631	8,851	2,526
R-Squared	0.18	0.21	0.13	0.13

CHAPTER 6

CONCLUSION

This is the first paper to measure the average historical life of ESOs of a broad set of firms, analyze factors driving the average life, and relate those findings to stated assumptions of expected life of ESOs. I find the mean life of ESOs to be consistent with another study using data from all employees, but shorter than the holding period for studies based on executives alone. The average reported expected life is higher than the average holding period. I find long run volatility, percentage of options granted to executives, vesting schedule, peak returns, risk-free rate, dividend yield, market to book, return on assets, and industry have the greatest impact on exercise behavior. I also find firms incorporate their own historical holdings into reported expected life, factor in the age of the options outstanding at the end of the year, and generally align their assumptions with industry peers. These results are qualitatively similar to results based on executives only but the model has significantly strong explanatory power.

I find deviations of reported assumptions from benchmark values are often a deviation from prior reported values in the same direction. Deviations from life benchmarks are slightly positively correlated with deviations from volatility benchmarks suggesting intentional manipulation of ESO expense or irrational expectations of the future. The net impact of these departures from benchmarks results in significant changes if FMV and reported earnings.

I test incentives to manipulate reported expense and stock option characteristics that may affect stock price. Unlike the extant literature, I do not find direct evidence of a relationship between deviations from benchmarks and incentives to manipulate ESO expense. Nevertheless, my results indicate subtle manipulation or irrational expectations of the future.

Noise in stock option expensing is important to the degree that it affects stock valuations. I show that deviations from benchmarks, both positive and negative, increase the subsequent excess volatility. I find statistically significant relationships between deviations from benchmarks and subsequent cumulative abnormal returns. Nevertheless, the underlying theory remains to be pinpointed.

The formation of benchmarks highlights the difficulties firms face in creating expectations for future results. Expected volatility should be based on historical volatility which is an easily obtained measurement for both the firm and the firm's peers. Yet deviation from own history, a simple and straightforward measurement, still has a standard deviation of 0.15. Expected life is even more difficult since the measurement window time span is subjective, treatment of outstanding options requires more expectations based on beliefs, and information about peers is not publicly available. Thus it is unclear how precise the benchmarks are and how much error there is in the firm's estimates of the future. Tests for manipulation suggests there are firm characteristics that lead to over and understating, but the reasoning behind these relationships is not yet clear. Future improvements to this study will improve the explanatory power of the regression-based benchmarks and attempt to provide better specification for models that explain the deviations from benchmarks.

REFERENCES

Aboody, David. 1996. Market valuation of employee stock options. *Journal of Accounting and Economics* 22 (August-December 1996): 357-391

Aboody, David, Mary Barth and Ron Kasznik. 2004. SFAS no. 123 Stock-Based Compensation Expense and Equity Market Values. *The Accounting Review* 79(April 2004): 251-275

Aboody, David, Mary Barth, and Ron Kasznik. 2006. Do Firms Understate Stock Option-Based Compensation Expense Disclosed under SFAS 123?. *Review of Accounting Studies* 11(2006): 429-461

Bartov, Eli and Carla Hayn. 2006. Change in investor sentiment regarding stock option accounting. Working paper, New York University (2006)

Bartov, Eli, Partha Mohanram, and Doron Nissim. 2007. Managerial discretion and the economic determinants of the disclosed volatility parameter for valuing ESOs. *Review of Accounting Studies* 12(2007): 155-179

Bettis, J. Carr, John Bizjak, and Michael Lemmon. 2005. Exercise behavior, valuation, and the incentive effects of employee stock options. *Journal of Financial Economics* 76(2005): 445-470

Black, Fischer, and Myron Scholes. 1973. The Pricing of Options and Corporate Liabilities. *Journal of Political Economy* 81(May–June 1973): 637–659

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

Choudhary, Preeti. 2010. Evidence on differences between Recognition and Disclosure: A Comparison of Inputs to Estimate Fair Values of Employee Stock Options. *Journal of Accounting and Economics,* Forthcoming (2010)

Fama, Eugene and Kenneth French. 1993. Common Risk Factors in the Returns on Stocks and Bonds. *Journal of Financial Economics* 33(1993): 3-56

Frederickson, James, Frank Hodge, and Jamie Pratt. 2006. The Evolution of Stock Option Accounting: Disclosure, Voluntary Recognition, Mandatory Recognition, and Disavowals. *Accounting Review* 81(2006): 1073-1093

Hall, Brian and Kevin Murphy. 2002. Stock options for undiversified executives. *Journal of Accounting and Economics* 33(2002): 3-42

Heath, Chip, Steven Huddart, and Mark Lang. 1999. Psychological Factors and Stock Option Exercise. *The Quarterly Journal of Economics* 114(1999): 601-627

Heckman, James J. 1979. Sample Selection Bias as a Specification Error. *Econometrica* 47(1979): 153-161

Hodder, Leslie, William Mayew, Mary Lea McAnally, and Connie Weaver. 2006. Employee Stock Option Fair-Value Estimates: Do Managerial Discretion and Incentives Explain Accuracy?. *Contemporary Accounting Research* 23(2006): 933-975

Huddart, Steven. 1994. Employee stock options. *Journal of Accounting and Economics* 18(1994): 207-231

Huddart, Steven and Mark Lang. 1996. Employee stock option exercises an empirical analysis. *Journal of Accounting and Economics* 21(1996): 5-43

Huddart, Steven and Mark Lang. 2003. Information Distribution with Firms: Evidence from Stock Option Exercises. *Journal of Accounting and Economics* 34(2003): 3-31

Murphy, Kevin. 1996. Reporting Choice and the 1992 Proxy Disclosure Rules. *Journal of Accounting, Auditing,and Finance* 11(Summer 1996): 497–515

Murphy, Kevin. 1999. Executive compensation. *Handbook of Labor Economics* 3(1999): 2485–2563

Nagelkerke, N. J. D. 1991. A note on a general definition of the coefficient of determination. *Biometrika* 78 (1991): 692-692

Ohlson, James. 1995. Earnings, Book Values, and Dividends in Equity Valuation. *Contemporary Accounting Research* 11(1995): 661–687

Yermack, David. 1998. Companies' Modest Claims About the Value of CEO Stock Option Awards. *Review of Quantitative Finance and Accounting* 10(1998): 207-226

APPENDIX A

SAMPLE SELECTION BIAS

The data for this dissertation are not widely available data, and thus require significant time and resources to collect. For the sample period 1998 to 2009, Compustat provides most of the data required but does not report the ESO valuation assumptions until 2004. The proprietary database supplied by Verus Research provides these assumptions for all dates for a subset of firms. For analysis of valuation assumptions, this study utilizes the Verus data only. Additionally the data are filtered for firms that grant predominantly 10 year options. The first column of Panel A of Table A1 shows that the Verus universe of firms is 3,575 of the 9,819 firms in Compustat that had options outstanding at some point during the sample period.

Additionally, Compustat does not report the weighted average remaining life of the options outstanding, a key component to determining the average life of the ESOs that were terminated during the fiscal year. This too is collected by Verus research. Nevertheless, at the time of original collection, the purpose of these data was not specified and certain collection practices made many of the firm-years invalid. These data are being corrected at the time of the writing of this dissertation, but the usable data are a subset of the Verus data. The first column of Panel A of Table A1 shows that 739 firms of 3,575 firms have at least one firm-year with a seven year average for ESO life.

Table A1

Selection Bias Analysis

The following table provides analysis to determine the extent of selection bias from the overall Compustat universe of firm with options outstanding, to the subsample of firms in the proprietary data provided by Verus Research, to the sub-subsample of firms with historical ESO life. All variables are defined in Tables 3 and 5. Panel A provides the percentage of firms in each industry as defined by the Fama-French 30 industry classifications for each dataset. Panel B provides basic statistics for key regressors for the three groups.

Panel A: Industry Comparison

		Industry													
Sample	N Firms	1	2	3	4	5	6	7	8	9	10	11	12	13	14
All with Options	9819	2%	0%	0%	2%	1%	1%	1%	12%	2%	0%	2%	1%	3%	1%
Assump Data	3575	2%	0%	0%	2%	1%	1%	1%	10%	2%	0%	3%	1%	3%	1%
Historical ESO Life	739	2%	1%	0%	1%	1%	2%	2%	11%	3%	0%	2%	2%	4%	2%

	Industry															
Sample	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
All with Options	1%	1%	3%	0%	4%	2%	3%	14%	13%	1%	2%	3%	4%	2%	16%	1%
Assump Data	1%	1%	1%	0%	4%	4%	3%	13%	12%	1%	2%	3%	6%	2%	17%	0%
Historical ESO Life	1%	1%	0%	0%	3%	4%	2%	11%	11%	2%	3%	3%	7%	1%	16%	0%

Panel B: Key Regressor Comparison

	N			Mean		
	All With Options	Assumption Data	Historical ESO Life	All With Options	Assumption Data	Historical ESO Life
$\overline{PctTop\,5}$	62,558	26,632	9,425	0.32	0.31	0.29
$Vest$	62,540	26,644	9,421	2.25	2.23	2.24
Vol_{Hist}	27,540	21,439	8,603	0.61	0.48	0.46
$\overline{Vol_{Sales}}$	57,335	24,646	9,041	0.09	0.06	0.05
$\overline{Ret5}$	33,710	23,952	9,117	0.33	1.14	1.15
$\overline{MaxRet5}$	34,011	24,024	9,129	0.57	0.42	0.42
$\overline{CAPMBeta}$	29,824	22,332	8,803	1.1	1.17	1.12
$\overline{DivYield}$	55,074	24,050	9,026	0.01	0.01	0.01
$\overline{\ln(TotAssts)}$	60,032	25,512	9,212	17.94	20.41	20.76
$\overline{\ln(SalesGrowth)}$	49,031	23,014	8,450	0.15	0.18	0.15
$\overline{M/B}$	62,979	26,663	9,438	1.02	2.16	2.56
$\overline{D/E}$	33,670	23,550	8,925	0.7	0.52	0.45
$\overline{ROA}$	59,832	25,488	9,203	-0.4	-0.02	-0.02
$\overline{R\&D}$	60,032	25,512	9,212	0.08	0.05	0.05
$\overline{HH}$	52,148	24,498	8,936	0.14	0.13	0.14

(Continued)

Table A1-*Continued*

Panel C: Heckman Selection Model for Historical Volatility

	Selection Model (p-value in parentheses) (1)	Structural Model (t-statistic in parentheses) (2)
Intercept	-20.61 (<.01)	1.21 (28.98)
$\overline{\ln(TotAssts)}$	1.05 (<.01)	-0.04 (-32.79)
$\overline{\ln(SalesGrowth)}$	0.55 (<.01)	0.04 (5.06)
$\overline{Vol_{Sales}}$	-0.39 (<.01)	0.42 (10.65)
$\overline{M/B}$	0.19 (<.01)	0.01 (5.02)
$\overline{D/E}$	-0.42 (<.01)	0.04 (18.56)
$\overline{ROA}$	0.78 (<.01)	-0.25 (-12.65)
$\overline{R\&D}$	2.31 (<.01)	0.24 (7.04)
$\overline{Capex}$	1.14 (<.01)	0.18 (3.91)
Two Digit SIC Code Dummies where both are models are significant	5 of 71	
Heckman Correlation Coefficient	-0.004 (t-statistic = -0.18)	

(Continue)

Table A1-*Continued*

Panel D: Heckman Selection Model for Historical ESO Life

	Selection Model (p-value in parentheses) (1)	Structural Model (t-statistic in parentheses) (2)
Intercept	-11.33 (<.01)	6.02 (4.8)
$\overline{PctTop\,5}$	0.96 (<.01)	1.13 (3.39)
Vest	0.07 (<.01)	0.12 (2.34)
Vol_{Hist}	1.15 (<.01)	-4.04 (-6.97)
$\overline{Vol_{Sales}}$	-1.54 (<.01)	-0.56 (-1)
$\overline{Ret5}$	0.01 (0.53)	-0.05 (-1.49)
$\overline{MaxRet5}$	-0.27 (<.01)	0.81 (3)
$\overline{CAPMBeta}$	-0.01 (0.81)	0.13 (1.33)
$\overline{DivYield}$	5.96 (<.01)	-12.69 (-3.75)
$\overline{\ln(TotAssts)}$	0.45 (<.01)	0.04 (0.99)
$\overline{\ln(SalesGrowth)}$	0.27 (<.01)	-0.13 (-0.56)
$\overline{M/B}$	0.08 (<.01)	0.06 (2.19)
$\overline{D/E}$	-0.3 (<.01)	0.06 (0.89)
$\overline{ROA}$	1.02 (<.01)	0.63 (1.98)
$\overline{R\&D}$	2.06 (<.01)	0.76 (0.91)
$\overline{HH}$	-0.12 (0.34)	-0.01 (-0.03)
Fama-French 30 Industry Dummies where both are models are significant	2 of 30	
Heckman Correlation Coefficient	-0.058 (t-statistic = -0.24)	

The historical selection of firms into the Verus database is considered by Verus to be a randomized process but the continuing refinement of the data is biased towards larger firms. The firms with adequate data for average ESO life calculations are considered a random subsample of the Verus firms, thus they should be no more biased than the overall Verus sample. To test for selection bias, I focus on specification of regression 1 of Table 3 and regression 1 of Table 5. Both of these regressions explain the historical volatility and historical ESO life respectively. Panel A of Table A1 shows the distribution of firms in the sample by industry under the Fama-French 30 industry definition. Both subsamples of data closely match Compustat with the greatest differences being for industries 20 and 27. Panel B shows the count and means for the key regressors of the two regressions focused on in this appendix. There do appear to be differences between Compustat and both subsets of data. With Verus focusing on larger firms, it appears the Verus universe consists of firms that are larger, more profitable, and less volatile. These factors could be important in explaining variations in historical volatility and historical ESO life.

To better characterize the effects of these differences in the data, I utilize the Heckman (1979) selection model. Under this model, rho represents the correlation of errors between the structural model of interest and the selection model that determines if the data do or do not appear in the structural model. An insignificant test of rho does not reject the null hypothesis that rho is equal to zero and that the selection model does not influence the estimates of the structural model. Panels C and D both show that many variables are significant in both the selection of data that appear in the structural model and the structural model itself. Nevertheless, both tests fail to reject the null hypothesis that rho is equal to zero. Thus I conclude that while the data are skewed towards larger more stable firms, the implications of the key estimations are not adversely affected.

APPENDIX B

HISTORICAL VOLATILITY

I construct four benchmarks similar to the expected life benchmarks. The first benchmark is actual historical volatility, Vol_{Hist} . It is defined as the annualized standard deviation of the natural log of one plus the monthly return, measured over the previous five years. The second benchmark, $\widehat{Vol}_{Hist}$, is fitted value based on the following regression:

$$Vol_{Hist} = \beta_0 + \beta_1 Vol_{Market} + \beta_2 \overline{\log(TotAssts)} + \beta_3 \overline{\log(SalesGrowth)} + \beta_4 \overline{M/B} + \beta_5 \overline{D/E} + \beta_6 \overline{ROA} + \beta_7 \overline{Treas7yr} + \beta_8 \overline{R\&D} + \beta_9 \overline{CAPEX} + Industry\ Fixed\ Effects \quad \text{(B1)}$$

Vol_{Market} is the annualized volatility of monthly returns for the previous five years for the value-weighted portfolio as defined by CRSP. All other variables have been previously defined and a bar over any variable means the variable is averaged over the previous five years. Industry fixed effects are defined by two digit SIC code due to the larger data set for historical volatility as compared to historical ESO life.

Panel A of Table B1 provides descriptive statistics for the sample for volatility estimation.[7] The first regression in Table B1 provides the estimates of Equation B2. Historical volatility, as specified in this model, is largely driven by

[7] The sample for expected life estimation is considerable smaller due to reductions to confirmed 10 year grants and the costly nature of manual cleaning of the data. When volatility is analyzed apart from expected life, the sample size is considerably larger.

market volatility, firms size, D/E, and ROA with standardized coefficients of 0.20, -0.31, 0.16, and -0.23 respectively. Industry fixed effects contribute an additional 8 percentage points to adjusted R-Squared.

The third benchmark, $Vol_{Hist10K}$, is the average of the reported expected volatility for the previous five years. I require a minimum of four observations to form this benchmark. The fourth benchmark, $\widehat{Vol}_{10K}$, is the is the fitted value based on the following regression:

$$\begin{aligned} Vol_{10K} = \beta_0 + \beta_1 Vol_{Hist1yr} + \beta_2 Vol_{Hist5yr} + \beta_3 Vol_{10K,Ind} + \beta_4 Vol_{Market} \\ + \beta_5 \overline{\log(TotAssts)} + \beta_6 \overline{\log(SalesGrowth)} + \beta_7 \overline{M/B} \\ + \beta_8 \overline{D/E} + \beta_9 \overline{ROA} + \beta_{10} Treas7yr + \beta_{11} \overline{R\&D} + \beta_{12} \overline{CAPEX} \\ + Industry\ Fixed\ Effects \end{aligned} \tag{B2}$$

$Vol_{Hist1yr}$, $Vol_{Hist5yr}$, *and* $Vol_{10K,\ Ind}$ are the annualized one year historical volatility of daily returns, annualized five year historical volatility of monthly returns, and median contemporaneous reported expected volatility for the 2-digit SIC code. All other variables have been previously defined. Averaged values, as indicated with a bar, are averaged over the prior 5 years as an expectation of future values. Industry fixed effects are defined by the 2-digit SIC code.

The second column of Panel B of Table B1 provides estimation results for Equation B2. When determining expected volatility for the 10-K, firms consider their own historical volatility (coefficients of .10 and .59 for short-term and long-term respectively), contemporaneous stated value for the industry (coefficient of

Table B1

Factors Affecting Volatility

Descriptive statistics for the sample are provided in Panel A. Panel B presents regressions results for formulation of the volatility benchmarks $\widehat{Vol}_{Hist}$ and $\widehat{Vol}_{10K}$. $Vol_{Hist1yr}$, Vol_{Hist}, Vol_{Market}, $Vol_{10K, Ind}$, and Vol_{10K} are the 1 year historical volatility of returns, 5 year historical volatility of returns, 5 year historical volatility returns of the market, median expected volatility for the 2-digit industry code, and expected volatility stated in the 10-K respectively. *TotAsst* is the total assets in billions. *Salesgrowth* is the percentage change in sales. *M/B* is the market to book ratio. *D/E* is total debt divided by market equity. *ROA* is operating income divided by total assets. *Treas7yr* is the implied return on a seven year government bond. *R&D* is research and development expense divided by total assets. *CAPEX* is capital expenditures divided by total assets. All variables with a bar above them are averaged over the previous five years. All tests control for industry fixed effects defined by 2-digit SIC code. All variables are Winsorized at the 1st and 99th percentiles. Errors are clustered at the firm level and t-statistics are reported in parentheses. Panel C provides descriptive statistics for all four benchmarks, the differences between the benchmarks, and the difference between volatility as stated in the 10-K and the benchmark. $Vol_{Hist10K}$ is the average of reported 10-K volatility for the previous five years.

Panel A: Descriptive Statistics for Sample

	N	Mean	Std Dev	Percentile 10th	25th	50th	75th	90th
Vol_{Hist}	0.49	0.25	0.22	0.30	0.44	0.64	0.85	0.49
Vol_{10K}	0.49	0.25	0.23	0.31	0.44	0.63	0.83	0.49
$Vol_{Hist1yr}$	0.53	0.30	0.23	0.32	0.45	0.67	0.93	0.53
$Vol_{10K,Ind}$	0.48	0.16	0.26	0.35	0.49	0.60	0.69	0.48
Vol_{Market}	0.15	0.03	0.09	0.13	0.16	0.18	0.19	0.15
$\overline{TotAssts}$	4.70	14.02	0.05	0.16	0.65	2.49	9.93	4.70
$\overline{SalesGrowth}$	0.24	0.52	-0.02	0.04	0.12	0.25	0.53	0.24
Vol_{Sales}	0.05	0.07	0.00	0.01	0.03	0.06	0.10	0.05
$\overline{M/B}$	2.48	2.38	0.01	1.01	1.83	3.22	5.60	2.48
$\overline{D/E}$	0.50	0.97	0.00	0.03	0.17	0.53	1.24	0.50
$\overline{ROA}$	-0.04	0.26	-0.22	-0.02	0.02	0.06	0.10	-0.04
Treas7yr	0.04	0.01	0.03	0.04	0.04	0.05	0.06	0.04
$\overline{R\&D}$	0.05	0.11	0.00	0.00	0.00	0.06	0.17	0.05
$\overline{CAPEX}$	0.05	0.05	0.00	0.01	0.03	0.06	0.10	0.05

(Continued)

Table B1-*Continued*

Panel B: Regression results for Volatility benchmark.

	Dependent Variables	
	Vol_{Hist} (1)	Vol_{10K} (2)
Intercept	0.92 (22.7)	0.39 (13.7)
$Vol_{Hist1yr}$		0.10 (14.12)
Vol_{Hist}		0.59 (52.3)
$Vol_{10K,Ind}$		0.16 (8.26)
Vol_{Market}	1.86 (59.92)	0.01 (0.38)
$\overline{\log(TotAssts)}$	-0.04 (-34.6)	-0.02 (-20.08)
$\overline{\log(SalesGrowth)}$	0.04 (6.79)	-0.01 (-0.82)
Vol_{Sales}	0.36 (11.45)	0.03 (1.32)
$\overline{M/B}$	0.01 (6.84)	0 (0.72)
$\overline{D/E}$	0.04 (19.44)	0 (0.17)
$\overline{ROA}$	-0.21 (-10.82)	-0.03 (-2.88)
$\overline{Treas7yr}$ (1), $Treas7yr$(2)	0.18 (1.09)	0.83 (7.79)
$\overline{R\&D}$	0.26 (8.76)	0.08 (3.19)
$\overline{CAPEX}$	0.07 (1.7)	-0.03 (-0.79)
N	53,297	27,762
Adjusted R-Squared	0.56	0.70

0.16), and many other factors that may drive future volatility including total assets (negative), ROA (negative), seven year government bond yield (positive), and R&D expenditures (positive). Unlike expected life, the determination of expected volatility closely matches the coefficients that drive historical volatility.