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New Data for Answering Old Questions About Employee Stock Options

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Abstract

This paper is a description and summary of existing questions and sources of data on stock options along with a detailed examination of one of the questions: what is the value employees place on stock options? The data sources include records of individual firms, consulting firms, survey data of employee perceptions, government and nonprofit sources, and international sources. Questions include why firms grant options, why are options granted throughout the firm, will new Financial Accounting Standards Board (FASB) rules change the way employees are compensated, are options an efficient way to pay, do options attract, retain and motivate workers, what is the issue with options backdating, what is the value employees place on options, and what is the cost of options to firms? We then explore one of the questions that has been in the literature for 20 years more deeply: what is the value employees place on stock options? We explore ways to consider this issue and some empirical evidence as well as a new way to test these ideas. We suggest that the idea that employees value options at a level different from Black-Scholes helps explain some perplexing findings from the previous literature. Finally, we discuss the implications of our findings for public policy and the reporting of stock options.
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A stock option is the right to buy a share of stock at a set price at some time in the future, subject to a vesting provision. The dramatic grown in the use of stock options in the past decade (Hall and Murphy, 2003), new Financial Accounting Standards Board (FASB) recommendations on how to account for stock options in firm balance sheets, and new disclosure requirements for highly paid executives in U.S. firms has sparked considerable debate about stock options in recent years.

In keeping with the tradition of the National Bureau of Economic Research (NBER) Conference on Research in Income and Wealth (CRIW) this paper aims to provide a review and update on some important questions in stock options research and practice, explore a variety of types of new and interesting data sets for the careful and credible study of stock options and incentives, and will examine in some detail the question of the value employees place on stock options.

There is a host of reasons why learning more about stock options is important for firms, the government and policymakers. First, over the past 15 years there has been dramatic growth in the use of stock options for senior-level executives and, beginning in the mid-1990s, substantial growth in the use of options for non-executive employees that was only partially dampened by the market adjustment in 2001. For example, among publicly traded firms, Hall and Murphy (2003) report that option grants to managers and employees who are not among the top five highest paid in the firm has grown from less than 85 percent of the total options granted to employees in the mid-1990s to over 90 percent by 2002. While there is some evidence that options to non-executives are less common in the past few years, they clearly remain an important dimension of compensation in many firms. We believe work like this, and additional work using information from other firms, will substantially contribute to our understanding about the circumstances in which firms choose to provide options to employees.

A second reason for providing this information to companies is the widespread debate about the appropriate method of estimating the cost of options and the value of options to firms. Although there

seem to be many strong opinions, until now, there is really no empirical evidence to bear on the issues. Black and Scholes (1973) and Merton (1973) developed numerical formulas for pricing options for risk-neutral, diversified investors. These techniques have been used successfully for more than three decades. However, the same techniques have been extended to consider the value of options to employees. Many have pointed out that the value to an employee may be considerably different than the value to an outside investor (e.g. Lambert, Larcker, and Verecchia, 1991). Using this idea, Hall and Murphy (2002) have run simulations based on assumptions about senior managers. Using these techniques, they show that employees value options at a level that is substantially less than the Black-Sholes value and the cost of the option to the firm.

A third motivation for this paper is the very lengthy debate over the appropriate method firms should use to estimate the cost of options to employees. FASB (2004) has recently proposed accounting standards that require firms to treat options as a compensation expense at the time they are granted. FASB asked for comment on their proposal and more than 6,500 letters were written as of the end of the summer of 2004 to offer opinions, suggestions, delays, changes, etc.

A fourth motivation for this paper is also very practical and speaks directly to whether particular firms should grant options to particular employees. Whenever a firm decides to grant options, it must decide whether it is better off granting the options or some alternative form of compensation. In order to do this appropriately a firm must know a) how the employees value the options relative to other forms of compensation, b) the costs of the options to the firm, and c) the incentive effects of the options (e.g. do they influence the employees to work harder)? Even if the options "cost" the firm more than other forms of pay, the firm may still want to provide them if "incentive effects" are high enough. Of course, answering part "c" is very difficult work.

We will begin this paper with a brief explanation and history of pricing for market-traded stock options, including the seminal Black-Scholes option pricing model (Black and Scholes, 1973 and Merton, 1973). We will then explore a variety of types of newer data sources for stock options research and explain a limited selection of findings from and examples of each type. These will include large survey

data sources of publicly traded firms such as Standard and Poor's Execucomp, data available from a firm called Equilar, and data from a firm called salary.com. We will also investigate a set of sources that use financial records from sets of individual firms (such as Core and Guay, 2001) or case studies of intricate details of option grant and exercise decisions within individual firms (such as Heath, Huddart and Lang, 1996 and Hallock and Olson, 2007). We will examine data sources from consulting firms (such as that used by Heron and Lie, 2007) and data from surveys on employee perceptions (such as Farrell, Krische and Sedatole, 2006). We will also examine a set of government and non-profit sources and international sources from countries such as Japan, Finland and the United Kingdom. In this section we will be careful to consider costs and benefits of each of these types of data sources.

Some questions related to employee stock options are well-understood. However, there still exist a host of issues that are as of yet unresolved. We will explore a number of these questions including, why some firms issue stock options throughout the firm, whether stock options are "efficient", the value of options to employees, the cost of options to the firms, and whether new FASB and stock exchange regulations will alter the way firms compensate employees.

The remainder of the paper will be devoted to a more detailed examination of one of these research questions: what is the value employee place on stock options? We examine the value employees place on stock options using data from multiple large grants of stock options to a large set of professional employees in a multi-billion dollar U.S. non-manufacturing firm. We show that employee exercise decisions are inconsistent with predictions from a model of market traded (not employee) stock options. Our estimates are inconsistent with the view that employees value options at less than the "Black-Scholes" value. We suggest a simple explanation for this finding: since employees cannot sell or borrow against their options, they do not face market pressure that would drive their options down to the Black-Scholes value. Our finding that options in this firm were valued by employees at a level above the Black-Scholes level suggests the value of the options to the employees is greater than the cost to the firm. Therefore, these employee stock options appear to be a source of considerable "competitive advantage" in this firm

Our hope is that our work is a useful guide to researchers, policy makers, and practitioners interested in the use and governance of stock options. We conclude by considering the implications of our findings on firms and the public, given the recent changes in regulations and governance of firms in the United States.

What are Stock Options and Motivation

A discussion about the value of options to employees begins with the pioneering work of Black and Scholes (1973) and Merton (1973) who describe the value to diversified investors of market traded stock options. The famous diagram shown in Figure 1a summarizes the basic relationship between the Black-Scholes value (BSV) of an option to buy a share of stock at a fixed price in the future (a call option), the firm's stock price and the option's exercise price.[1] The kinked *intrinsic value* line equals $\text{Max}((SP_t - EP), 0)$ where SP_t is the price of the firm's stock in period t and EP is the exercise price of the stock option and corresponds to the payoff that could be made by immediately exercising the option and then selling the acquired share at the firm's stock price. The curved line in the figure is the BSV and is the price that an unexercised option could be bought or sold for that is predicted from the Black-Scholes theory. The BSV is a function of six variables - the risk free interest rate, the expiration date of the option, the variance in the firm's stock returns, the firm's dividend rate, the option exercise price and the current stock price. If "T" is the time period when the option expires and the current period is "0", $BSV^{T}_{t=0}$ is equal to the $E_{t=0}(\text{Max}((SP_T - EP),0))$ discounted using the risk free interest rate (r_f). Figure 2 shows the BSV values for an option with an exercise price of $10 that expires in 10, 5 and 0.5 years for a "typical" firm.[2] When the stock price is $10 and the option expires in 10 years the BSV estimate of the market value of the option is $5.57. Thus, even though a profit cannot be made by immediately

[1] A call option is the right to buy a share of stock in the future at a pre-determined price.
[2] The standard deviation of the firm's returns over a year is .3, no dividends are paid by the firm and the risk free interest rate is 6 percent.

exercising the option on the grant date, it has significant value because of the expectations of investors that at the end of the ten year period a significant profit is expected (but not guaranteed) because of a significantly higher, expected stock price when the option expires. The market value of the option on the option grant increases as the duration of the option increases because the expected stock price on the expiration date increases as the option's duration increases. If the option shown in Figure 1a expires in five years its value at a $10 stock price is $3.80 and if the option expires in 6 months its market value is $.99 at a $10 stock price. The relationship between the stock price and BSV for options with these three terms is shown in Figure 1b.

An important result shown by Black, Scholes and Merton is that the market value of an option depends on the riskless rate of return and does not depend on the firm's expected return which includes a firm specific risk premium. The prediction that owners of market traded options can only expect to earn the riskless rate of return by holding the option is because investors can eliminate the risk that the option will be worthless when it expires because the stock price is less than the exercise price with a hedging strategy. For example, an investor could buy a "put" option that gives the owner the right to *sell* a share of stock at $10/share in period T. This put option will pay a profit to its owner if the call option is "underwater" ($SP_T < EP$). Owning this put ensures the investor will make a profit at time T no matter what the stock price happens to be on the expiration day. While firms discourage employees from owning put options because these options are a "bet against the company" and earn money only if the firm's stock price falls, for outside investors this strategy is a simple way of eliminating the risk associated from owning a call option. This ability of investors to hedge risk means competitive market pressures will cause options prices to converge to a price that earns only a riskless rate of return.

More formally the Black-Scholes option pricing formula can be written as:

$$BSV = (SP)\Phi\left(\frac{\ln((SP)/(EP) + (r_f + \sigma^2/2)t}{\sigma\sqrt{t}}\right) - (EP)e^{(-r_f t)}\Phi\left(\frac{\ln((SP)/(EP) + (r_f + \sigma^2/2)t - 1}{\sigma\sqrt{t}}\right)$$

Where r_f is the risk-free rate of interest, σ is the standard deviation of returns for the underlying stock, t is time in years until the option expires, and Φ is the cumulative standard normal distribution function.

The BSV value is always greater than the intrinsic value because the present value of the expected profit that can be made by holding the option until it expires is greater than the profit that can be made by immediately exercising the option and earning a profit equal to the option's intrinsic value. The differential between the option's BSV and its intrinsic value reflects the expectations of investors that the expected value of the option on its expiration date discounted to the current period is greater than the intrinsic value. The formula assumes the firm's stock returns are normally distributed and uncorrelated from one period to the next. The assumption that returns are normally distributed means the price of a riskless asset in T periods is drawn from a log-normal price distribution. As the option expiration date approaches, the Black-Scholes line shifts towards the intrinsic value line because the chances of observing a large increase in the firm's stock price prior to the expiration date also declines.

There is considerable debate among researchers, policymakers and practitioners about many issues related to stock options including their incentives effects, the value employees place on them, how they should be reported, etc. We will discuss several of these issues in this work but begin with a description of some useful data sources that may be useful in considering these and other questions about employee stock options.

Survey of Data Sources in the United States and Elsewhere

Along with the explosion in the past few decades in the use of stock options by firms in the United States has been a dramatic increase in research on employee stock options. In this section we will examine seven types of data sources and give a few brief examples of research from each type. This list is not meant to be comprehensive; rather we intend to give an overview of the types of analyses and sources that now exist. The seven types are i) commercial executive-level and firm-level sources, ii) individual firm financial records at the firm level, iii) individual firm financial records at the person-level,

iv) consulting firm data, v) employee perception data from surveys, vi) government and nonprofit sources, and vii) international sources. Table 1 outlines the data sources and a selection of referenced papers discussed in this section.

Commercial Executive-Level and Firm-Level data Sources

There are at least three available commercial data sources on executive pay at the person-level and firm-level that are now available and relatively widely used. The first, ExecuComp (Executive Compensation data base) is produced by Standard and Poor's Corporation and is likely the most widely used source of data for research on executive pay, including stock options. This source has available data from 1992 – present on the compensation of the top five highest employees of U.S. publicly traded firms who have managerial control in roughly 1,500 firms per year. These firms include those listed in the Standard and Poor's 500, the Standard and Poor's SmallCap 600, and the Standard and Poor's MidCap 400. The data source starts in 1992 which was (until this past year) the last major change in executive pay disclosure rules. Bergman and Jenter (2007) is a fine example of recent employee options research using ExecuComp. The paper describes data on the option grants to top 5 execs for a sample of roughly 1,500 firms from 1992-2003. From the information on the grants and their reported fractions of the whole to "top 5 executives", it is easy to calculate the number of options given to all employees. In the paper Bergman and Jenter consider why employees are given compensation in the form of options. They test whether it is the case that employee optimism may be the reason and find that optimism alone is not sufficient to make this form of compensation optimal. Chidambaran and Nagpurnanand (2005) is another example of the use of ExecuComp. They evaluate 864 executive repricings of options in 240 firm repricings from 1992 through 1997 in Execucomp. Mehran and Tracy (2001) provide a summary of some executive pay research using data from ExecuComp.

Two other commercial executive pay sources are much more often used by practitioners and have garnered less attention from academics. Equilar and salary.com also provide comprehensive data sets of executive compensation but have a larger focus on marketing to the for-profit firm and compensation consulting market. These sources are frequently used by compensation design practitioners and

consultants to help design executive pay plans (and to set comparison groups) including detailed equity and employee stock option plans.

One problem with these sources is that they only focus on the most senior executives with managerial control over the firm. If one is interested in the compensation of any employee who is not in the "top 5 highest paid" these data sources are not particularly useful. They do, however, reveal the fraction of options given to the sum of the top five highest-paid officers so that one can calculate the fraction granted to the rest of the employees in the firm. Another drawback of these data is that that only cover publicly traded firms. Finally, ExecuComp is for a limited set of firms. Data from Equilar and salary.com are more expensive but include information from a wide variety of firms.

Individual Firm Financial Records (firm-level)

A host of scholars have also considered firm financial records at the firm level but have not used the well-known ExecuComp and related sources; rather they have dug deeper for more unique sources of information. We will discuss a selection of these examples here.

Aboody (1996) used the National Automation Accounting Research System (NAARS) library on Lexis/Nexis in 1988. This useful source includes information on the financial statement footnotes on the number of outstanding fixed options for a large number of firms. The author examined all firms that had a ratio of outstanding options to outstanding stock of over 5%. This yielded 672 firms. Among his findings is a negative correlation between the value of outstanding options and the price of the firm's outstanding common stock.

Non-executive stock options plans have received considerably less attention (due to data constraints) and are less prevalent. Core and Guay (2001) study the determinants of non-executive employee stock option holdings, grants, and exercises from 756 firms from 1994-1997. They use data from 10-Ks of firms and data on "top 5" executive holdings from ExecuComp. They find that when firms face higher capital and financing constraints they are more likely to compensate employees with stock options.

Carpenter (1998) collected information on average time to exercise, stock prices at the time of exercise and vesting periods using data from 10-Ks, proxies and S-8 forms (the option plan prospectus). These forms are now listed for all publicly traded firms on the Securities and Exchange Commission (SEC) web page. Carpenter uses detailed data from 40 firms to consider the exercise and valuation of employee stock options.

Individual Firm Detailed Case Study Data (person-level)

There have been an increasing number of individual-firm case studies over the past decade that have greatly enriched our understanding of employee stock options. Although these kinds of studies have the obvious drawback that the results may apply to only one (or a small number of) firms, they are often extraordinarily rich in detail about the firm. This point is extremely important. Too often, economic and financial scholars are interested in discovering things such as the "incentive effects" of a particular pay policy. In fact, the viability of a particular pay plan may depend quite a bit of the type of workers the firm employs and the strategy and objectives of the firm.

Armstrong, Jagolinzer, and Larcker (2006) call into question the appropriateness of simple "option-exercise-timing-adjusted" employee option valuation models suggested by FASB. They use detailed data from ten publicly traded U.S. firms including information on strike price, maximum term, and vesting schedule for each option grant to each employee. Their sample includes several tens of thousands of options.

In some of our own work (Hallock and Olson, 2007a and Hallock and Olson, 2007b) we examine data from two separate firms to consider the value of options to employees and employees' choice of mix of pay. The first sample is from a very large non-manufacturing firm that made 13 sets of option grants to a set of more than 2,000 professional workers over a decade starting in the early 1990s. We will discuss our valuation method and empirical results (e.g. that employees in this firm value options at a level higher than the Black-Scholes level) in more detail below. In another paper we have detailed compensation and demographic data for each employee of a high-tech firm. This firm set the total compensation level of

employees but allowed individual employees choice over the fraction of pay they wanted in salary, at-risk bonus, and stock options. Workers of different demographic groups made substantially different choices.

Two very important and early papers that use unique data from firms are Health, Huddart, and Lang (1999) and Huddart and Lang (1996). The authors use individual by individual option grant and exercise data and individual exercise behavior of 50,000 individuals at seven corporations. The firms include four NYSE firms (a manufacturer, two financial institutions, and a high-tech firm), and three NASDAQ "recent" public high-tech firms. Samples span from August 2, 1985 through December 23, 1994. Huddart and Lang (1996) find that employee exercise behavior is strongly related to recent stock price movements, the employee's level in the firm, the spread between the market price and the strike price, and proximity to vesting dates. Heath, Huddart, and Lang (1996) find strong evidence that psychological factors influence exercise behavior. Two examples include the fact that exercise activity is significantly higher when the stock price reaches a 52-week high and that exercise activity is related to stock price trends.

Bajaj, Mazumdar, Surana, and Unni (2006) use data from two firms to consider the valuation of employee stock options and find that ESO valuation methods suggested by FAS 123R such as adjusting the expected life of the ESO and making adjustments to the Black-Scholes value lead to substantial biases in option valuation. They use data from two technology firms. The first tracks 4.34 billion ESOs granted through the company in 464,205 grants. The second is a complete history of 142 million options granted in 54,720 grants.

Again, each of these papers makes a unique contribution and shows the details that can be learned from extraordinarily specific data. However, each study also suffers from the drawback that they are studying a very small set of firms.

Consulting Firm Data

An increasing number of scholars have made connections with consulting firms to use data from a variety of firms at once in one study. These have the obvious advantage that more firms are included. In some cases, there are fewer details than in some of the case studies previously discussed.

A recent study by Heron and Lie (2007) investigated whether stock option backdating explained price patterns around executive stock option grants. The authors use data on stock options grants from Thomson Financial which collects information from insider transactions of stock and derivative grants and exercises from SEC forms 3, 4, 5 and 144.

Landsman, Peasnell, Pope, and Yeh (2006) consider which approach to accounting for stock options best reflects market pricing. They use 1,354 firm-year observations drawn from the S&P 500 from 1997 – 2001 from Jack Ciesielski of R.G. Associates.

Employee perception data from surveys

One way to consider the value employees place on stock options is to ask employees. Farrell, Krische, and Sedatole (2006) use "confidential training data files" of New Worth Strategies, Inc. (NWSI), a national leader in equity compensation planning services: to help understand this issue. They examine how a training program may help employees understand their employee stock options better.

Hodge, Rajgopal, and Shevlin (2006) investigate individual perceptions of the value of stock options and restricted stock. They conclude that a mix of economic, behavioral, and demographic factors explain managers' valuations of these equity instruments. They use data from 77 executives attending a one day program and 111 MBA students at Northwestern. The authors specifically asked individuals to evaluate compensation packages that contain equity instruments.

Government and Nonprofit Sources

There are a set of government and nonprofit data sources that contain different types of information on employee stock options. Kroumova and Sesil (2006) consider the predictors of employee stock option plans. They find that firms with greater levels of intellectual capital and capital intensity are more likely to adopt option plans. The unit of observation these researchers are interested in is the firm. They use data from National Center for Employee Ownership (NCEO) in 1998 on 600 public and private firms sponsoring some form of broad-based stock option plan.

Oyer and Schaefer have two papers that use these types of sources. Oyer and Schaefer (2006) consider options costs and use the NCEO Survey on Current Practices in Broad-Based Stock Option Plan

Design. This is a survey mailed to plan administrators in firms with "broad-based stock option plan" in place. Oyer and Schaefer (2005) use a "representative random sample" of U.S. for-profit establishments from the Bureau of Labor Statistics. In particular they study 1,437 establishments employing 680,000 people provided complete answers to the survey. They also examine 1,000 randomly selected publicly traded U.S. firms and collect information about option granting behavior from 1999 financial disclosures. They consider reasons why firms give options to all employees. They find that sorting and retention ideas are supported by the data.

International Data

Although much of the focus of this paper is on employee stock options in the United States (and rules on grant, exercise and taxation of options vary widely) we summarize a selection of international data sources on employee options in this section.

Ikaheimo, Kuosa, and Puttonen (2006) examine the "most actively traded ESO companies (14 plans of 6 companies), which represents 98.7 percent of total value of ESO trades on the Helsinki Stock Exchange (HEX)." They analyze the pricing of 27,808 trades and conclude that the standard Black-Scholes model "clearly overstates the value of ESOs which should be expensed by companies".

In another study using Finnish data Jones, Kalmi, and Makinen (2006) use firm-level data on option plans from all Finnish firms from 1990 – 2002. Among their findings are that larger firms are more likely to use options and stock returns in the previous year are correlated with "targeted" but not broad-based plans.

Kato, Kiyoski, Lemmon, Luo, and Schallheim (2005) investigate 644 adoptions of stock option plans announced by Japanese firms following the amendment of the Japanese commercial code in May 1997. This code allowed, for the first time, options to be grated in Japanese firms. They found improvements in operating performance among the firms that adopted plans.

Data from the U.K. were used in Pendleton (2006) which investigated the behavior of participants in the U.K.'s Save as You Earn (SAYE) stock option programs. Data were collected from five large U.K. companies from employee surveys in 1999. The data were collected by a share-lobbying

organization Proshare and financed by Halifax (now part of HBOS PLC) and Abbey National PLCs. 24,976 surveys were sent out and 4,795 (24%) were returned. The author found that participant's age and investment portfolios affected the probability that they retained stock.

Data from different countries certainly add to the richness of what we know about employee stock options. At the same time, we need to be careful in interpreting results across countries due to the quite different reporting and tax rules on stock and employee stock options across country boundaries.

What Do We Know and What Do We Want to Know About Employee Stock Options?

In this section we outline a series of questions that have been studied in the past decades concerning employee stock options. Some of these questions have been answered but many have solutions that are not yet known. The questions include why do firms grant options, do options retain employees, do they motivate employees, do they attract employees, why are they granted (in some cases) throughout the firm, will the recent FASB changes alter the way employees are paid, how well do options work, why don't more firms use indexed options, are options efficient, what is the value employees place on options, what is the cost of options to the firm, and what are issues surrounding options backdating?

Are options efficient?

Hall and Murphy (2003) cover a host of interesting issues with respect to employee stock options. One issue they consider is whether options are an "efficient" form of compensation. They point out that options are a way to help solve the well-known agency problem between managers and shareholders. At the same time they recognize that the vast majority of options are granted to individuals who are not among the very highest paid in their firm so that we should consider retention, motivation, and attraction of employees. The bottom line issue is what is the difference between the cost of options to the firm and the value employees place on options? Both are issues to which we will return later in this paper.

Do options retain employees?

Given vesting provisions on most options it is certainly reasonable to think about whether employee stock options help to retain employees. There are other ways (besides options) that employers can pay employee that may be cheaper than options (e.g. retention bonuses). As Hall and Murphy (2003) point out, it is not clear that the retention level should vary explicitly with the stock price as they do with employee stock options.

Do options motivate employees?

As Hall and Murphy (2003) note "it seems implausible that stock options provide meaningful incentives to lower-level employees, especially given obvious free-rider problems." Hall and Murphy (2003) note that options may help employers communicate corporate objectives to employees and this may be a useful feature of equity-based pay. They also note, however that lower-level employees holding options in a down market could be unusually unhappy.

Do options attract employees?

It is also reasonable to think that options may attract employees to the firm. However, one convincing paper by Oyer and Schafer (2005) provides evidence that is inconsistent with this hypothesis.

Why do firms grant options throughout the firm?

Starbucks has a unique and interesting compensation strategy and philosophy. One of the Human Resource practices that the firm engages in is that is offers stocks options at *everyone* in the firm. Will individual employees in a Starbucks outlet have any influence over the stock price? Probably not – so why do they do it?

There is surprisingly little academic literature on this question. A notable exception is Oyer and Schaefer (2005) who ask "Why do some firms give stock options to all employees?" The authors consider three leading explanations for why employers provide options: incentives for employees, inducements for employee to sort, and employee retention. The authors find no support for the incentives explanation but do find that their results are consistent with both the sorting and retention hypotheses.

The empirical work uses data from three sources but concentrates on middle managers alone. The paper is convincing but this literature could be improved with concentration on a wider variety of workers.

Will the Financial Accounting Standard Board (FASB) rule change the way employees are paid?

Prior to the FASB change for expensing of options there was a great deal of discussion about the likely affects of the rule change. One the one hand some authors (e.g. Bodie, Kalpan, and Merton, 2003) noted that options are an expense and should be included as such in a firms balance sheet. Others argued that even though options were not included as an expense that market prices reflected the use of options appropriately since options grants had always been disclosed in footnotes to financial statements. An interesting avenue for future work will be to consider whether the FASB change affected options grants and how to credibly separate this from other economy-wide effects.

How should firms report options costs and report them in their balance sheets?

Until the recent change by FASB U.S. firms did not have to account for stock options in their balance sheets. Consider firms A which has $1,000,000 in revenue, has no non-compensation costs and pays employees $1,000,000 in cash and firm B which has $1,000,000 in revenue, has non non-compensation costs and pays $1,000,000 in stock options to employees. Until recently firm A would report earnings of $0 and firm B could report earnings of $1,000,000.

One of the reasons for the difficulty in reporting options in firms' balance sheets is the difficulty in considering the value of options to employees. Some have argued that employees may value options at a level less than the Black-Scholes level designed for market traded options (e.g. Lambert, Larcker and Verecchia, 1991 and Hall and Murphy, 2003). In December of 2004 FASB adopted new standards for how firms report employee stock options as an expense at the time options are granted. The new rules require that firms use Black-Scholes or a "Black-Scholes-like" formula to expense options and encourages firms to include in their costs estimates of the expected exercise pattern of employees because this pattern affects the cost of options to the firm. There is still considerable variation in the way firms report options as an expense on their balance sheet and this is an important open question in the literature.

Why don't more firms use "indexed" options?

Prior to the new changes by FASB almost no firms offered stock options with an "indexed" or floating exercise price. The reason for this was (under the old rules) that if the strike price was set at the time of the grant, then the options were not counted as an expense. However, if the strike price was not fixed in advance then the options were to be counted as an expense. So, from an accounting point of view, prior to 2004, indexed options were much more "expensive" since they needed to be counted as an expense and non-indexed options were not.

Since the FASB change, all options must be treated as an expense. There are potential advantages to granting indexed options, the most prominent perhaps is that they are a form of relative performance evaluation (Antle and Smith, 1986 and Gibbons and Murphy, 1990), whereby employees can only earn a profit if their firm's stock perform better relative to the comparison group. This form of compensation does, however, place a lot of risk on the employee. It would also be difficult to account for options at the time of the grant.

What is the value employees place on stock options?

The value employees place on options is the subject of the next major section of this paper. As we will discuss in more detail below, this is a difficult, interesting and open question. A host of researchers have been working on this issue for nearly 20 years.

What is the cost of the options to the firm?

Although Black-Scholes does not make a prediction about how long an employee will hold an option, modeling the length of time employees hold options is important because of its impact on the cost of options to the firm. When employees exercise options early, they forfeit the expected gains from holding the option until it expires. By foregoing these gains, all else equal, the cost to the firm of providing the employee stock option is less than the Black-Scholes value of an option held for the term of the option grant.

This relationship between employee exercise decisions and firm option costs is reflected in the FASB proposal where the preferred costing method uses historical data on the distribution of employee

exercise times and a lattice model (e.g. a binomial tree) to account for "early" exercise decisions. If historical data on the distribution of exercise times is unavailable, then FASB suggests firms use Black-Scholes or a similar formula where the term of the option is set equal to the expected exercise time for the population of employees receiving options. FASB recognizes the importance of exercise times for determining the cost of options to a firm. However, it only focuses on the expected time options are held or the distribution of option times generated by a single decision rule that is incorporated into the lattice model. It does not adequately discuss how the distribution of exercise times affects option costs or how the mean (or distribution) of exercise times should be computed. In our discussion of this we will present an alternative method where we use reduced form random-effects probit estimates of exercise decisions and then use these to simulate the distribution of exercise times over a set of possible stock price paths.

How accurate is an estimate of the mean exercise time if a firm were to follow current practice and calculate the mean exercise time from the exercise times from one option grant? One way to answer this question for the firm we have studied is to examine the distribution of expected exercise times calculated from a "simulation exercise" and compare the results with the historical data from the firm we study using one of the option grants.

In some of our previous work (Hallock and Olson, 2007) we documented that exercise patterns are strongly related to the current firm stock price. Therefore, past exercise activity is dependent on past stock price patterns (more employees will have exercise options if stock prices were "high" than if stock prices were "low"). Therefore, the FASB suggestion to use past exercise behavior (which is based on past stock prices) to predict future exercise behavior (which will be based on future prices) is akin to predicting future stock prices with past stock prices.

In summary, our results suggest that a careful analysis of expected exercise times must go beyond calculating the mean exercise time using the exercise history from a recent option grant. Since the future price path is unknown, our results suggest a careful analysis of the expected exercise times needs to include a detailed econometric analysis and simulation exercise comparable to what we have done in our previous work.

What do we know about options backdating?

Options backdating has received an unusual amount of attention in the past year or so. Backdating is, in fact, legal *if each* of four conditions is met (Lie, 2007). First, no documents can have been forged. Second, the backdating must be communicated to shareholders. Third, backdating must be appropriately reflected in the company earnings statements. Fourth, taxes must be appropriately paid on the backdated options.

A decade ago Yermack (1997) found that executives seemed to be granted options and stock at unusually opportune times and exercise options or sell stock at unusually opportune times as well. Some interpreted this as a managers being able to manipulate news about firms. Subsequent work by Lie (2005) found that stock prices tended to decrease before employee stock options grants. In that paper, he stated "Unless executives posses an extraordinary ability to forecast the future market wide movements that drive … predicted returns, these results suggest that at least some awards are timed retroactively." Subsequently an avalanche of suits have been filed against hundreds of firms concerning the legality of stock option backdating in firms.

The Value Employees Place on Options

Considering the value employees place on their own employee options is difficult. For some time researchers held the view that the value employees place on employee stock options could be different from the value disinterested, diversified investors placed on market tradable options. Examples of this kind of discussion include Lambert, Larcker, and Verecchia (1991) who, among others, argued that because employees were not risk neutral or diversified that they must value employee options in their firms at a level lower than the Black-Scholes value. Subsequent simulation work by Hall and Murphy (2002) showed that, conditional on a set of assumptions about utility functions and risk-aversion parameters, executives valued options at a level less than the Black-Scholes value for market tradable options.

Beyond the reasons why employees may value options at a level that is different from Black-Scholes discussed above, there are several other limitations to using the Black-Scholes method in considering employee stock options. First, the Black-Scholes model predicts that market traded options held by diversified investors will never be exercised early because options can always be sold for more than the stock price – exercise price (this difference is the intrinsic value). In fact, employees do exercise options early. In the case examined here and explained in more detail below, only 10 percent of options are held until month 96 (of a 96 month exercise period). Second, since employees cannot sell their options, their only choice is between exercising the option or holding the option for another period. The Black-Scholes model makes no prediction at all about how long employees will hold options. Finally, since employee stock options are not traded, employees have no way of determining the market value of their own options

An important prediction of the Black-Scholes model is that a diversified investor will never exercise the right to buy a share of stock until the moment before it expires because, as Figure 1b shows, at any earlier date the expected gain from holding the option until the expiration date is greater than the profit that can be made by immediately exercising it. The expectation of a stock price increase between now and the expiration date means the Black-Scholes value is greater than the profit that could be made by immediately exercising the option and receiving the option's intrinsic value, (SP_t-EP). Therefore, the Black-Scholes model predicts that prior to the expiration date an investor will sell an option rather than exercise it if they wish to convert an option to cash because the BSV, the sale price, is greater than (SP_t-EP).

Previous research has concluded that the BSV of an employee stock option is a poor estimate of the value of the option to an employee who receives it as part of her compensation package. The evidence cited to support this conclusion includes the observation that employees frequently exercise ESO "early" or well before the option's expiration date (Huddart and Lang, 1996; Carpenter 1998). In the firm we study 86 percent of employees exercised their options prior to the month before the options expired and half of the sample exercised some of their options at least 27 months prior to the option's

expiration date.[3] In a simulation study, Hall & Murphy (2002) show risk averse executives who also have a substantial portion of their personal wealth invested in the firm may exercise "early" to lock-in gains from large stock price increases and diversify their portfolio. Heath, Huddart and Lang (1999) find that employees tend to exercise options when the firm's stock price exceeds a target or referent price based on recent stock price highs. Since an employee must typically forfeit her options if she leaves the firm, early exercise decisions may also be caused by voluntary or involuntary employee turnover (Carpenter 1998).

The observation that employees frequently exercise ESOs "early" compared to the Black-Scholes prediction for market traded options partially reflects the fact that employees cannot sell the options they receive from their employer and must exercise the options if they wish to liquidate their position to diversify their portfolio or meet a household demand for cash. This feature of ESOs implies information about an option's value to an employee is revealed each period by observing whether or not a vested option is exercised. If an option is not exercised in a period then the value to the employee of holding the option and reserving the right to exercise it in a later period is greater than the value from immediately exercising the option and receiving the option's intrinsic value. On the other hand, when an employee exercises an option we know the value of holding the option another period is less than what is gained by exercising the option and receiving a payment equal to the stock price minus the exercise price. Thus, the decision to exercise immediately or hold an option for at least another period is an indicator of the current value to an employee of holding the option relative to the option's intrinsic value.

One important implication of the preceding prediction is that variation in the length of time until employees exercise their options reflects heterogeneity in the value employees place on holding their options for another period. This heterogeneity in the value of an ESO could reflect differences in turnover intentions because employees must typically forfeit their ESO when they leave the firm. It may also reflect differences in household risk aversion, the effects of binding liquidity constraints or different predictions about the future stock price of the firm. More risk averse employees may exercise early to "lock-in" profits (Hall & Murphy 2002) and the inability of employees to borrow against their ESO may

[3] These data are for the first large ESO grant awards made to the middle level managers included in this study.

cause some employees to exercise options to meet family financial commitments (buying house, college tuition or unanticipated health care expenditures). While these same sources of heterogeneity may also characterize owners of market traded options, because Black-Scholes predicts owners of market traded options can sell and hedge their options, market traded options are identically valued (conditional on the six variables identified above) regardless of the risk preferences and liquidity constraints on their owners. Thus, heterogeneity in exercise times is strong evidence that Black-Scholes does not measure the value of ESO to employees.

The data we have from the firm we studied includes the entire 10 year exercise history by a sample of employees holding options that were granted on the same date and that have identical terms. [4] All the options from this grant had the same strike price and expired ten years from the grant date and vested after two years. These common features mean that on each day in the 96 month exercise window the same profit would be received by exercising an option by all option holders and when making the exercise decision they face the same public information about the firm, the same exogenous macro-economic environment and an identical time horizon until the options expired. We also focused only on the exercise behavior of the 1735 option holders who remained with the firm for the entire 10 year term of the option. This largely eliminates heterogeneity in option valuation because of anticipated turnover. Evidence from this grant provides the strongest and simplest evidence of substantial heterogeneity in the value of ESOs to employees which is unrelated to turnover intentions.

Daily data on employee exercise decisions were aggregated into calendar months and Figure 3 shows the distribution of first exercise times over the 96 month exercise window. This figure shows options were exercised over almost the entire 96 months with about 1 percent of the sample exercising options each month after about 2 years except for the final months when exercise activity increased. The mean exercise time was 63.3 months into the 96 month exercise window, the median was 69 months and the 25th and 75th percentiles were 40 and 90 months.

[4] Two year vesting means the options could not be exercised until 24 months after the grant date.

Is the variation in exercise time in Figure 3 substantial? As explained above, if employees valued options based on Black-Scholes the distribution of exercise times would have a single mass point equal to 1.0 in month 96; all the options would be exercised in month 96. Or, if employees identically valued options at another value all of the exercise activity would have occurred in another month. The data clearly reject the prediction of a single exercise date.

The variation in exercise times implies substantial heterogeneity in the value employees place on holding their options. What more can be said? First, the upward sloping dotted line and the right vertical scale in Figure 3 shows the profit an employee can make by exercising an option divided by the option's BSV (i.e., $(SP_k - EP)/ BSV^T_{t=k}$, k=1,2…96). This ratio approximates the portion of the option's market value that is captured by exercising in any particular month rather than holding the option until the expiration date. One minus this ratio also indexes the penalty employees incur because they cannot sell their options. For example, for this option grant in month 20 an employee would lose about 30 percent of the option's value by immediately exercising the option. The variation in the potential value of the option sacrificed by "early" decisions is further evidence of substantial variation in the value of options to employees.

While much of the exercise activity summarized in Figure 3 is "early" relative to what would be expected if ESO could be sold, the exercise pattern may be optimal for risk averse employees who can't sell their options and who also have their careers, human capital and retirement income tied to the company. Thus, the different value employees place on identical options may reflect differences in employee aversion with the least risk averse employees holding options until the end of the exercise window. This hypothesis can be investigated by focusing on the 18.3 percent of the sample in Figure 3 that held their options until the end of the exercise window and exercised their options in months 94, 95 or 96. For this option grant the intrinsic value of the option at the start of month 94 was about $25 per option. Thus, almost 20 percent of the sample was willing to forego the $25 at the start of month 94 in order to capture the expected gain from holding the option for at most an additional three months. What

could employees expect to gain over this 3 month period and what does their behavior imply about their risk aversion and their expectations about the firm's stock price over this three month period?

Assuming the stock price at the beginning of month 94 equals \$30[5] and the exercise price equals \$5, the Black-Scholes value of an option expiring in three months is \$25.085 using reasonable values for the other Black-Scholes parameters.[6] Thus, a diversified, risk-neutral investor would be willing to hold their option for the remaining three months to collect the expected gain of about nine cents or a return of 0.36 percent (.09/25.00) above what could be earned by immediately exercising the option.

The Black-Scholes value of the option at the end of month 94 can be compared with the value from holding the option until month 96 for a risk averse employee who predicts the firm's stock price at the end of month 96 is based on the risk adjusted return the firm earns in the market and the variance in these returns. Following the Hall and Murphy (2002) methodology, the dollar value to a risk averse employee from holding the option until the end of month 96 is referred to as the "certainty-equivalent" dollar value of the uncertain payoffs from holding the options another three months. Risk aversion is measured by a parameter, ra, that could range from zero (risk neutral) to some small positive number (< 4). In these calculations we adopt a very standard mathematical formula used by economists to measure utility; the value or utility of "w" dollars to a risk-averse employee is $(w^{(1-ra)})/(1-ra)$.[7] At the start of month 94 we assume employees predict that the stock price distribution from which the stock price at the end of month 96 will be drawn from is based on a normal distribution of annual returns ($\sigma = .30$) centered around the risk free return (6 percent) plus the risk premium investors expect to earn by holding this firm's stock (14 percent).[8] The utility function and the ending stock price distribution from these assumptions is used to calculate the certain cash payment employees would be willing to receive at the end of month 93 that would make these employee indifferent between exercising and holding the option

[5] Again, we do not report the actual number since we are unable to disclose the name of the firm.
[6] This assumes the short-term risk-free interest rate equals 4 percent/year and the standard deviation of yearly firm returns equals .30. These numbers are roughly representative of the firm and time period for this option grant.
[7] If ra=1 then U(w) = ln(w).
[8] The certainty equivalent values are computed by approximating the log-normal price distribution at the end of month 96 using a binomial price tree with 120 terminal prices.

until the expiration day. The average number of options/grant that employees received in our sample was about 1300. Therefore, the certainty equivalents were calculated assuming employees that had not exercised any options from the grant at the end of the 93rd month owned 1000 options.

Table 2 shows the results from this exercise for different levels of risk aversion. The first row of numbers are based on the Black-Scholes model and report $E(Max(SP_{96} - EP, 0))$, the expected value of the option at the end of month 96 assuming risk free returns are earned on the options and correspond to the $25.085/option (right hand column assuming no discounting) described above. The remaining rows of the table give the certainty equivalent values for different levels of risk aversion where the final stock price is based on a draw from an annual return distribution $N(.20, .3^2)$. The second row is a risk neutral evaluation of the options that is greater than the BSV because BSV assumes market traded options earn an expected rate of return equal to the risk-free interest rate (6 percent), while an employee owning an option that cannot be sold observes the firm's stock price growing at rate that includes the firm's stock market risk premium (20 percent). This difference leads to a larger expected gain from holding the option for the risk neutral employee and at the end of month 93. She would forfeit the options for a guaranteed payment of $26,154 at the end of month 96 or almost $1100 greater than the comparable value of $25,085 for market traded options. This example illustrates the important point that if employees were risk neutral and could not trade or sell their options, they could plausibly value ESO the options at more than their BSV.

Economists generally believe that individuals are risk averse and there is no reason to believe the mid-level managers and professionals in this sample have different preferences. Therefore, the remaining rows in the Table report more plausible certainty equivalent values for different levels of risk aversion. Hall & Murphy's evaluation of past research leads them to conclude from that a risk aversion parameter between two and three is a reasonable range for the low end of plausible risk aversion parameters. They are interested in using a lower bound value for risk aversion because they apply the model to senior executives who have substantially more wealth than the general population. The third row of Table 2 shows that for a risk aversion parameter of 2.0, the certainty-equivalent value at the end of month 93 for a

1000 options is $25,328 or $328 more than the $25,000 profit that could be earned by immediately exercising the options. This net gain from holding suggests an employee with ra=2 would rationally decide not to exercise the options at the end of month 93. When ra= 3.0 the certainty equivalent value is $24,917 or $83 less than the value from immediately exercising the options. We'd expect rational option holders who have a value of risk aversion of 3.0 to exercise at the end of month 93. A risk aversion parameter of 2.8 gives a certainty equivalent value exactly equal to $25,000. Thus, individuals less risk averse than this threshold would be predicted to hold their options and those more risk averse would be predicted to exercise their options. Any risk aversion parameter greater than 2.8 produces a certainty-equivalent value of less than the $25,000 in profit that could be made by exercising the 1000 options. A risk aversion parameter of less than 2.8 would provide a basis for "rationally" continuing to hold the options and is a plausible value for the subset of employees in Figure 3 who held their options through month 93.

The calculations in Table 2 that show moderately risk averse employees could form rational expectations about the firm's future stock price and justifiably hold their options past the 93rd month. The only difficulty with these rational evaluations is that they are greater than the option's BSV and could not be sustained if the options could be publicly traded. If employees holding options at the end of month 93 with a risk aversion parameter < 2.8 were allowed to sell their options to the public, they would discover they had over-valued their options and nobody would pay more than the BSV. This is because if ESO could be freely bought and sold option purchasers could hedge their investment so the purchase of the option would be riskless and could then only earn the riskless rate of return. This leads to the prediction that the heterogeneity in valuations show in Table 2 and implied by the dispersed exercise times in Figure 3 for the entire sample would disappear if these options were tradable because the market price would converge to the BSV. The valuations don't reflect BSV because employees cannot sell the options, they cannot observe the prices for options with comparably long terms (10 years) and they can't borrow money from a bank using the options as collateral. Any of these factors might cause employees to value options closer to BSV. Thus, employees are left with very few market signals to guide their exercise strategies

and are likely to overvalue ESO because they forecast the firm's future stock price distribution using the observed, risk adjusted return earned by the firm's shareholders.

Inferring the Value of Options to Employees Based on Their Exercise Decisions

It is possible to go beyond the calculations shown in Table 2 and conduct a statistical analysis of exercise behavior that can be used to infer the value employees place on ESOs. We define the Employee Value Function ($EVF_{k,j,t}$) to be equal the value or utility (in dollars) to person "j" in month "t" from holding an option from grant "k" another time period. "t" measures the months since the option vested and ranges from 1 to 96 because we study 10 year option grants with a two year vesting period. In each month after vesting we assume the employee decides between holding the option another period or exercising the option (the instrinsic value at that point) by comparing the profit from exercising the option with the value of holding the option at least another period. Since $SP_t - EP_{k,j}$ equals the certain cash payment the employee receives from exercising the option, the option will be exercised if this cash payment is greater than the monetary value to the employee of holding the option another period. In other words, the option is exercised in month "t" if

(1a) $(SP_t - EP_{k,j}) > EVF_{k,j,t}$

and the option is held another period if

(1b) $(SP_t - EP_{k,j}) \leq EVF_{k,j,t}$.

The left side of Eq. 1a is observed and equals the intrinsic value of the option or the profit that is made by exercising the option in month t. In the statistical analysis EVF is a function of a matrix of observable (to the researchers) "X" variables including characteristics of the individual (salary and tenure) and the option (its BSV, time until the option expires), unobservable (to us) variables that include unchanging and unobserved characteristics of the individual (u_j) and random unobserved shocks that are unique for each month, employee and option grant ($e_{k,j,,t}$). We denote the sum of the unobserved variables by ν and assume they are normally distributed. Thus,

(2) $EVF_{k,j,t} = X_{k.j,t}\beta + v_{k,j,t}$, where $v \sim N(0,\sigma^2_v)$.

The exercise probability is defined in Figure 4 where the EVF line is equal to the weighted sum of the observed variables (Xβ) and the normal distribution around the EVF line denotes the distribution of the unobserved (ν) determinants of EVF. Conditional on the observables, the probability the option is exercised is the probability that $v_{k,j,1}$ is sufficiently small to cause EVF to be less than SP_1 -EP. This probability is easily calculated given the normality assumption for ν.

While there are strong theoretical reasons to believe economically rational employees who exercise their options value holding their options at less than BSV for the reasons discussed earlier, in practice employees may have great difficulty using Black-Scholes as a benchmark in their personal valuations because the absence of a ESO market gives employees limited information about the value outside investors would place on their options. The 10 year term of a typical ESO is far longer than market traded options that may exist for most firms and employees have no way of determining the value an outside investor or lender would place on the option since employees cannot sell their options or use them as collateral for a loan. Without market information, it is unlikely the typical employee in this sample will be knowledgeable about option pricing theory or able to solve an option pricing problem that won a Nobel Prize in economics for Merton and Scholes.

However, experimentation with how well different models predicted exercise decisions led us to prefer a model that makes use of one piece of market information employees do have when valuing their options. Employees do observe the firm's stock price when making their exercise decisions. Standard results in finance show *any* rational model employees use to value their options will produce an option value less than the firm's stock price because an employee is always better off owning the share of stock when given the choice between an option and a share of stock where each is priced at SP (Brealey, Myers & Marcus 1995). If SP ≤ EP on the expiration date the option is worth nothing but the share of stock is still worth SP>0. If SP > EP the share of stock is also worth more than the option as the option is worth SP-EP and the share of stock is worth SP. Thus, a rational employee will never value an option at more

than the stock's current price. This fact is used to estimate a truncated model where EVF is constrained to be less than the firm's stock price. Figure 4b shows how this constraint changes the exercise probability in a month. Note that the normal distribution of the unobservables in the model does not extend above the firm's stock price.

The models summarized in Figures 4a and 4b describe the probability an option is exercised in a single month and not *which* month in the 96 month window an option is first exercised. Since we seek to predict which month in the 96 month exercise window an employee first exercises an option from a grant, the model in Figure 4b is expanded to estimate when an option is exercised in the exercise window. The probability an option from grant k is first exercised in the month t is the probability an option from the grant is not exercised in months before month t but then exercised in month t. This probability is

$$(3)\quad \Pr(\textit{Exercised in } t) =$$

$$\Pr((SP_1 - EP_{k,j}) \le EVF_{k,j,1}, (SP_2 - EP_{k,j}) \le EVF_{k,j,2}, \ldots (SP_{t-1} - EP_{k,j}) \le EVF_{k,j,t-1}, (SP_t - EP_{k,j}) > EVF_{k,j,t})$$

We estimated the parameters of the EVF using Eq. 3 and the truncated model summarized in Figure 4b.

The Data

There are a variety of data requirements and complicated statistical issues that we solved to numerically estimate the employee value function that are not discuss in detail here.[9] Solving these problems took considerable time and effort; several years passed from the time we had developed the main ideas for this study and the beginning of our data analysis because it took considerable time and effort to find data sufficiently detailed to meet the requirements for estimating the model. Briefly, the data needed to include information on exercise behavior for a sample of employees that received multiple option grants at different exercise prices and at different points in calendar time. We received access to this kind of data for 2180 middle level managers in a large, established firm outside of manufacturing that

[9] See Hallock & Olson (2007) for a discussion of these issues.

has many tens of thousands of employees, billions of dollars in sales and locations throughout the United States.[10] These employees received options at 13 different exercise prices on 13 different days in the 1990s with the majority of the grants occurring on two calendar dates where one exercise price was almost twice the magnitude of the other exercise price.[11] In the research we summarize here we use data on the exercise decisions made by employees for options received in at least the first two grants an employee participated in during the 1990s where the options from the grants had vested before the fall of 2003.

Table 3 contains descriptive statistics on the sample of option grants. A total of 3712 options grants were received by the 2180 employees and all but 1127 of these grants were exercised during the study period (e.g., were not right censored). An interesting feature of the experience in this firm is that not all options from a grant were exercised in the same month. In about 42 percent of the option grants where we observe the first exercise date (e.g., the exercise time is not right censored), the employee did not exercise all of the options in the grant. On the other hand, overall 77 percent of the total options that could have been exercised were exercised by employees on their first exercise date for a grant. For this reason only the time until the first option from a grant is exercised is examined. A final important feature of the sample is that it excludes managers who joined the firm during the 1990s or managers who received options during the 1990s but left the firm before the Fall of 2003. Thus, these results describe the exercise decisions of long-tenured, stable employees who did not exercise options in anticipation of leaving the firm. Excluding option recipients who left the firm during the study period simplifies the analysis because we don't have to jointly model employee turnover and option exercise decisions.[12]

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[10] A condition for obtaining data from the firm included a promise that we would not reveal the identity of the firm. Therefore, we cannot provide a more detailed description of the firm or make the data available to other researchers.

[11] In all cases the options were granted "at the money." That is, the exercise price was equal to the firm's stock price on the day of the grant.

[12] Firms often report that they provide options to improve employee retention. Modeling option exercise decisions and turnover is difficult. While options might reduce turnover, employees that are planning to leave the firm can be expected to exercise vested options before their departure. This creates a positive correlation between exercise decisions and the probability of turnover in the "near term." Modeling exercise decisions and turnover behavior jointly would require a more elaborate competing risk framework and data on employees who did not receive options.

Figures 5a and 5b report data on the exercise decisions made by employees in the sample. Figure 4a is the survival curve for the time to the first exercise date for the 3712 option grants. Twenty-five percent of the grants are exercised by the 34th month following vesting, the median exercise time is 69 months and the 75th percentile of the exercise distribution is 90 months. Figure 5b plots the smoothed hazard rate over the first 95 months and shows a relatively stable but low hazard rate during the first 72 months and then a sharp increase in the final year as unexercised options are exercised before they expire.[13] Over the first 72 months of the exercise window an average of 1.11 percent of unexercised option grants were exercised for the first time in each month.

Employee Estimates of an Option's Value

Before discussing the estimated dollar value employees place on holding their options, it is useful to evaluate how well the statistical model described above predicts the exercise behavior in the sample. If the model does a good job of predicting exercise behavior then a reader should have greater confidence in how these estimates translate into the EVF. This comparison was accomplished by comparing the actual survival curve in the data with the predicted survival curve from each of the models. A survival curve describes the fraction of employees that had not yet exercised an option from a grant at the end of each of the 96 months in the exercise window. Thus, the predicted survival probability for month T for individual j from the statistical model is simply the predicted probability an option had not been exercised at the end of period T or the probability it was not exercised in period T given that it had not been exercised in any of the earlier periods from 1 through (T-1). A comparison of the actual survival curve with the survival curve predicted from the statistical model provides a summary of how well the model predicts exercise decisions. Figure 6 shows the estimated and the actual sample survival curve from these data. This graph shows the predicted survival curve calculated from the statistical model closely

[13] The hazard rate for month 96 is equal to one and is excluded from the smoothed hazard in Figure 4b.

tracks the actual sample survival curve. In other words, our model appears to do a good job of predicting when over the 96 month period employees decided to first exercise options from a grant.

The estimates from the statistical model of exercise decisions were used to calculate the predicted dollar value an "average" employee places on holding an option as the time period left until the option expires changes. These predictions are shown in Figure 7 along with the BSV, the stock price and the intrinsic value for an option with an exercise price of $5 and a constant stock price of $20.[14] Figure 7 shows employees over-value their option's compared to the BSV of a comparable market traded option. This is consistent with our discussion of Table 2 and does not necessarily mean employee valuations are irrational. On the option's vesting date the E(EVF) is about $1.50 or about 9 percent above the option's BSV. Over about the first 84 months of the window the over-valuation increases as the option's BSV declines with the approaching expiration date while the EVF remains basically unchanged. In the final year the EVF declines but remains about $2.00 greater than the option's BSV and the certain, intrinsic value that could be obtained by exercising the option immediately before it expires.

In Figure 7 the difference between the EVF line and the option's intrinsic value is the net benefit from continuing to hold the option by an average employee in the sample. This gap can be compared to the difference between the intrinsic value and the certainty equivalent value from holding the option assuming different levels of risk aversion. In other words, we can compare certainty equivalent calculations like those shown in Table 2 with the statistical estimates of the EVF. Since the statistical analysis is not constrained to produce an estimated risk aversion parameter, this comparison allows us to evaluate whether or not the results are consistent with plausible levels of risk aversion. These differences are shown in Figure 8. The interesting point to note in Figure 8 is that the certainty equivalent values from holding an option for ra = 2 and ra = 3 bracket the estimate of EVF over most of the exercise window. The estimated EVF is greater than the two certainty equivalent values only in the first 30 months of the exercise window and over this range the differences are not very substantial. We believe

[14] An "average" employee has values of tenure, wages, and options owned equal to the sample averages. A real stock price of $20 and an exercise price of $5 are close to the average values in the sample.

these results show are estimates are plausible estimates of the value employees place on options and that risk averse and heterogeneity among employees is important understanding employee exercise decisions.

Our statistical analysis also found three other important facts about the exercise decisions of employees in this study. First, exercise probabilities were negatively correlated with an employee's wage. This implies higher salaried employees hold options longer than their lower wage colleagues. This result is consistent with the prediction that higher wage employees hold options longer because they are less risk averse or face less binding household budget constraints that may lead to early exercise decisions. Second, factors that are constant within individuals over time that affect their exercise decisions and are not included in our model play an important role in exercise decisions. This "unobserved individual heterogeneity" implies employees who exercised options "early" from an early grant are also likely to be "early" exercisers of options from a second grant for reasons not controlled for by the observables in the model. The significance of these unobserved individual effects shows the importance of unobserved (by us) factors such as employee risk aversion and liquidity constraints that cause individuals to systematically differ in their willingness to hold an option. For example, if risk aversion is one of the important unobserved variables in the model, our results imply individuals more risk averse than average will have a greater probability of exercising their option's early in the exercise window and individuals less risk averse than average will dominate the sub-sample of individuals that hold their options to the end of the exercise window.

Third, we also find that exercise patterns are sensitive to the overall path the firm's stock price follows through the term of the option. Simulations using the estimates from our model show the fraction of employees who have not yet exercised any options from a grant (the survival curve) depends on whether the firm's stock price has been more or less bullish. Employees tend to hold onto their options longer when confronted with the price path with higher average returns relative to a stock price path that generates lower monthly returns. These results have important implications for the cost of options to the firm because the firm's costs are positively related to both the length of time employees hold their options and the exercise price (Hall & Murphy, 2002). Finally, we find an employee's exercise

probability increases when the firm's stock price exceeds the previous 12 month stock price maximum. This implies some employees are using the 12 month price high as a referent when evaluating the utility of exercising their options. This is consistent with Prospect Theory (Kahneman & Tversky, 1973, 1979) in psychology and previous research by Heath et al. (1999).

CRIW: Implications for Firms and Public Policy

In the past few years there have been dramatic shifts in public perceptions of and government regulations over how executives and other employees are paid in the United States. Given that one of the goals of the Conference of Research in Income and Wealth is to "bring together economists from government, academe, business, and non-profit organizations to discuss problems of mutual interest," we highlight some of the recent policy shifts and additional pressures on firms designing compensation plans in this section.

Just a few years ago, firms in the United States were not required to "expense" stock options in their balance sheets. This meant only recently and for the first time, U.S. firms had to report options as an expense in the balance sheet, not just in footnotes to financial statements.

This paper has summarized a large set of data sources in the United States and throughout the world in order to give the reader an overview of the kinds of data available for work in the area. At the same time, we have outlined a host of solved and as-of-yet unresolved questions in the employee stock options literature. Our hope is that this will spawn new research in the area.

There are several new and continuing regulatory issues on the horizon that deal with compensation and stock options. One that is interesting is the way that firms have been required to report on executive compensation. Even though there has been considerable reform, there is still confusion about the way firms report options in the "summary compensation table". Firms are given wide leeway in the assumptions they can make about certain forms of compensation and how they report. We anticipate more reforms and changes along these lines in the near future.

New work on stock options has the potential to have a practical impact on firms. If firms do not have a credible estimate of how employees value stock options or other forms of compensation and firms alter the mix of pay, there could be consequences related to employee attraction, retention, and turnover. We hope that our work is a useful step in the right direction of understanding more about compensation and employee stock options.

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Table 1. Types of Data Sources (and Examples of Each) on Employee Stock Options

Type	Authors	Comments
Commercial Sources		
Execucomp	Bergman and Jenter (2007)	1,500 firms, details on options of top 5 execs from 1992-2003
	Chiambaran and Nagpurnanand (2005)	Focus on repricing
	Mehran and Tracy (2001)	Review
Equilar, salary.com		
Individual Firm Financial Records (firm-level)	Aboody (1996)	National Automation Accounting Research System NAARS) library of financial statement footnotes
	Carpenter (1998)	Average exercise times by firm
	Core and Guay (2001)	Non-exec option holdings, grants and exercises from 756 firms from 1994-1997
Individual Firm Detailed Case Study (person-level)	Armstrong, Jagolinzer, and Lang (2006)	10 publicly traded firms
	Bajaj, Mazumdar, Surana, and Unni (2006)	Two firms, enormous numbers of option grants
	Hallock and Olson (2007a)	Large firm outside of manufacturing, 13 grants to 2000 middle managers over a decade
	Hallock and Olson (2007b)	Data from a different firm on pay mix, including options
	Heath, Huddart, and Lang (1996) and Huddart and Lang (1996)	Individual grant and exercise data from seven firms
Consulting Firm Data	Farrell, Krische, and Sedatole (2006)	Training data from equity compensation planning firm
	Heron and Lie (2007)	7.2 million stock and options transactions
	Landsman, Peasnell, Pope, and Yeh (2006)	1,354 firm-year observations from S&P500 from 1997-2001
Perception Data from Surveys	Farrell, Krische, and Sedatole (2006)	Training data from equity compensation planning firm
	Hodge, Rajgopal, and Shevlin (2006)	Executives in class
Government and Nonprofit Sources	Kroumova and Sesil (2006) and Oyer and Schaefer (2006)	National Center for Employee Ownership (NCEO) survey sent to plan administrators with plans in place – firm-level data for 600 firms
	Oyer and Schaefer (2006)	BLS establishment-level data from 1,437 establishments
International Data	Ikaheimo, Kuosa, and Puttonen (2006)	14 plans, 6 firms, 27,808 transactions in Finland
	Jones, Kalmi, and Makinen (2006)	Option plans in all firms in Finland from 1900-2002
	Kato, Lemmon, Luo, and Schallheim (2005), and Pendleton	644 stock option plan adoptions in Japan following 1997 rule change

TABLE 2

Values Of 1000 3 Month Option With An Exercise Price Of $5 And A Current Stock Price Of $30

	E(U($P-EP)) Assuming No Discounting	E(U($P-EP)) Discounted At Risk-Free Interest Rate
Black-Scholes Value	$25,530	$25,099
Risk Aversion Parameter[1]	Certainty-Equivalent Values	
Risk-Neutral	$26,802	$26,350
1.0	$26,309	$25,865
1.5	$26,063	$25,624
2.0	$25,818	$25,383
2.5	$25,574	$25,143
3.0	$25,330	$24,904
3.5	$25,088	$24,665

1. $U(x) = W^{(1-ra)}/(1-ra)$ for ra ? 1 and U(x)=ln(x) for ra = 1.
The risk neutral interest rate is 6 percent, the firm's risk premium is .14 percent and the standard deviation of weekly firm returns is .30.

Table 3

Summary Statistics on Exercise Decisions

Number of Employees Receiving Options	2180
Number of Option Grants	3712
Number of option grants where time to first exercise date is censored	1127
Mean options/grant	1302
Mean hazard rate/month	0.0128
25th Percentile of Time to 1st exercise date (months)	34
Median time to first exercise date (months)	69
75th Percentile of Time to 1st exercise date (months)	90
Options exercised on first exercise date as fraction of options in the grant	0.765
Fraction of first exercise decisions where 100% of options in grant were exercised	0.576

Figure 1

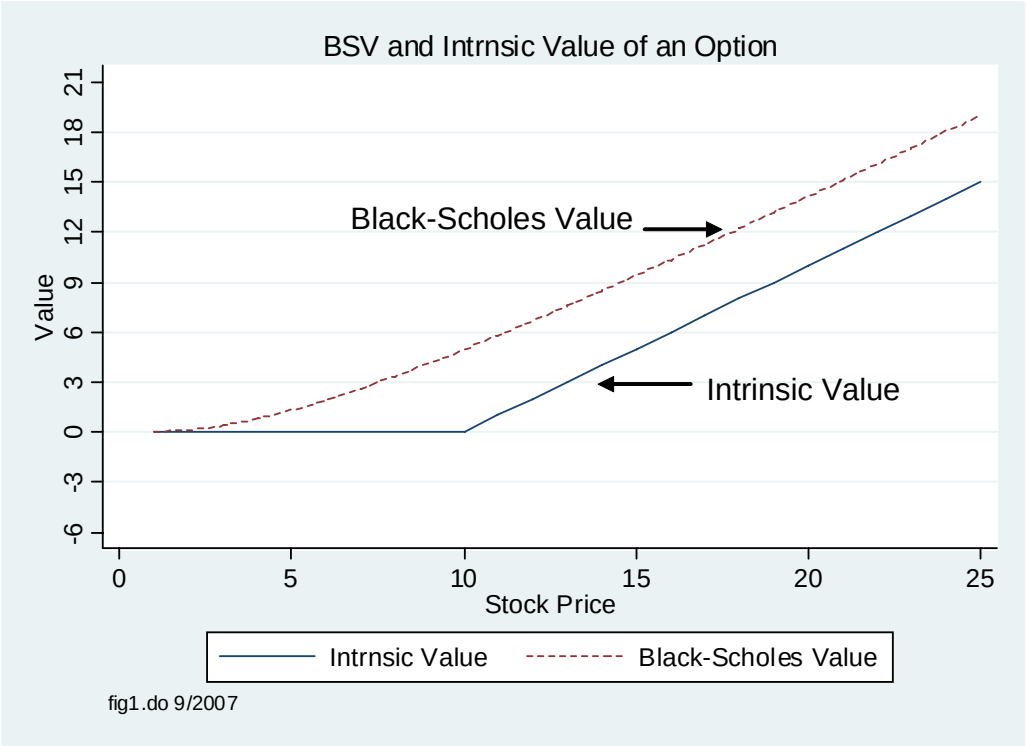


Figure 2

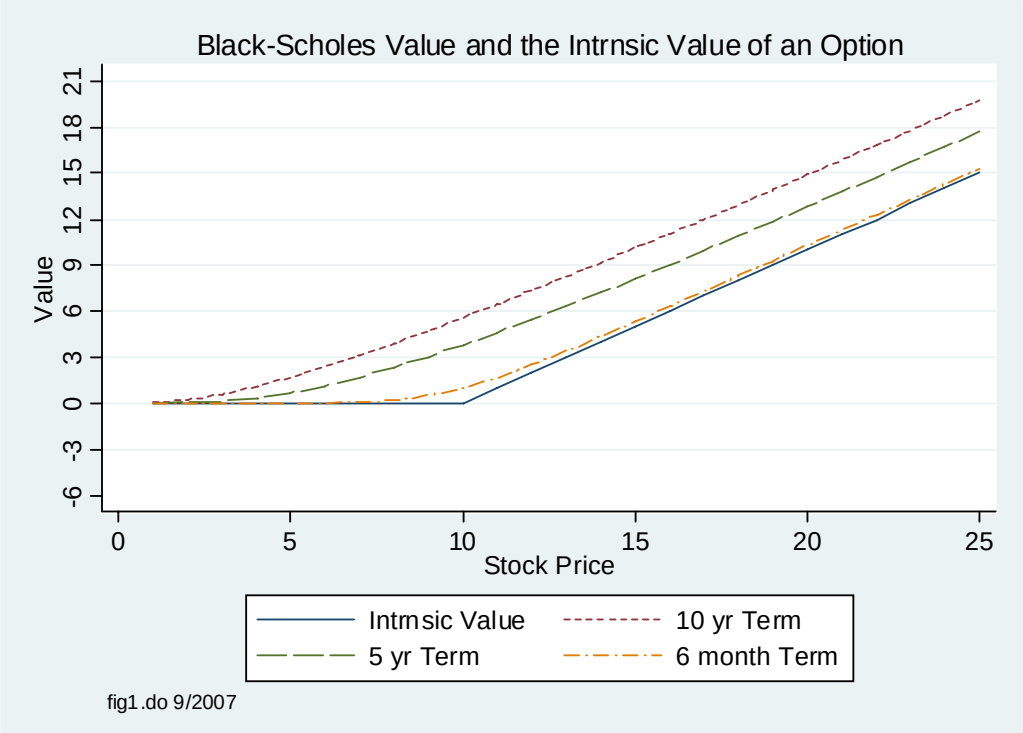


Figure 3

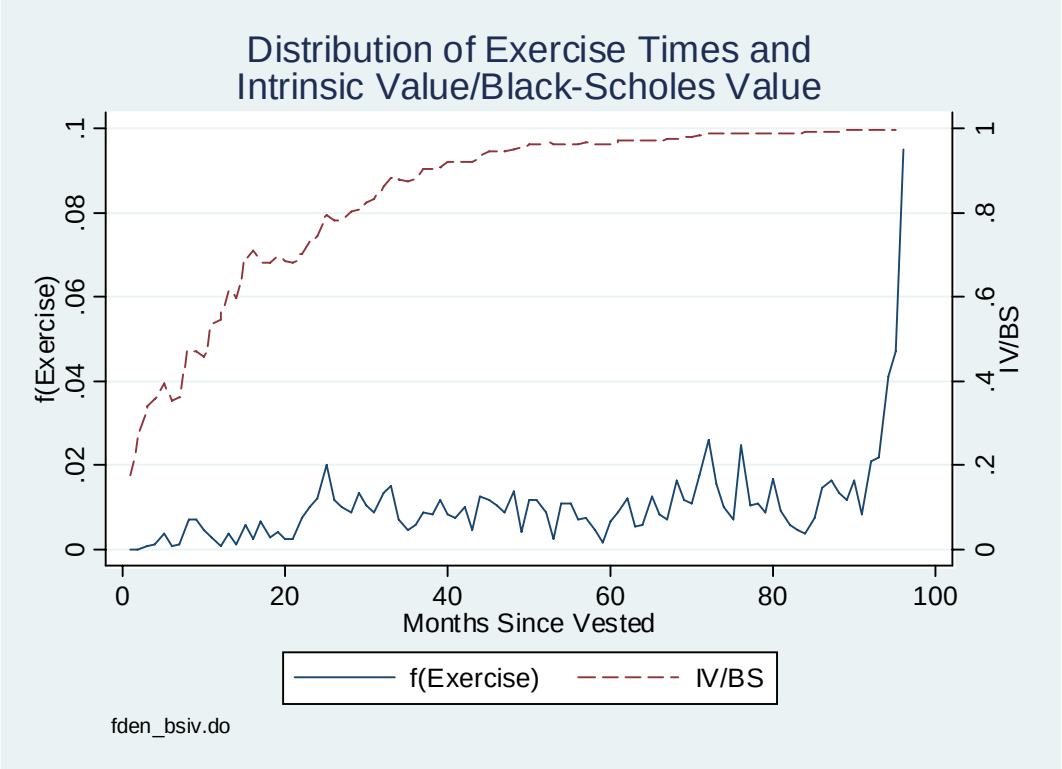

Distribution of Exercise Times and
Intrinsic Value/Black-Scholes Value
f(Exercise)
0
.02
.04
.06
.08
.1
IV/BS
0
.2
.4
.6
.8
1
0
20
40
60
80
100
Months Since Vested
f(Exercise)
IV/BS
fden_bsiv.do

Figure 4a

Black-Scholes Value and The Value of An Option To An Employee (Employee Value Function)

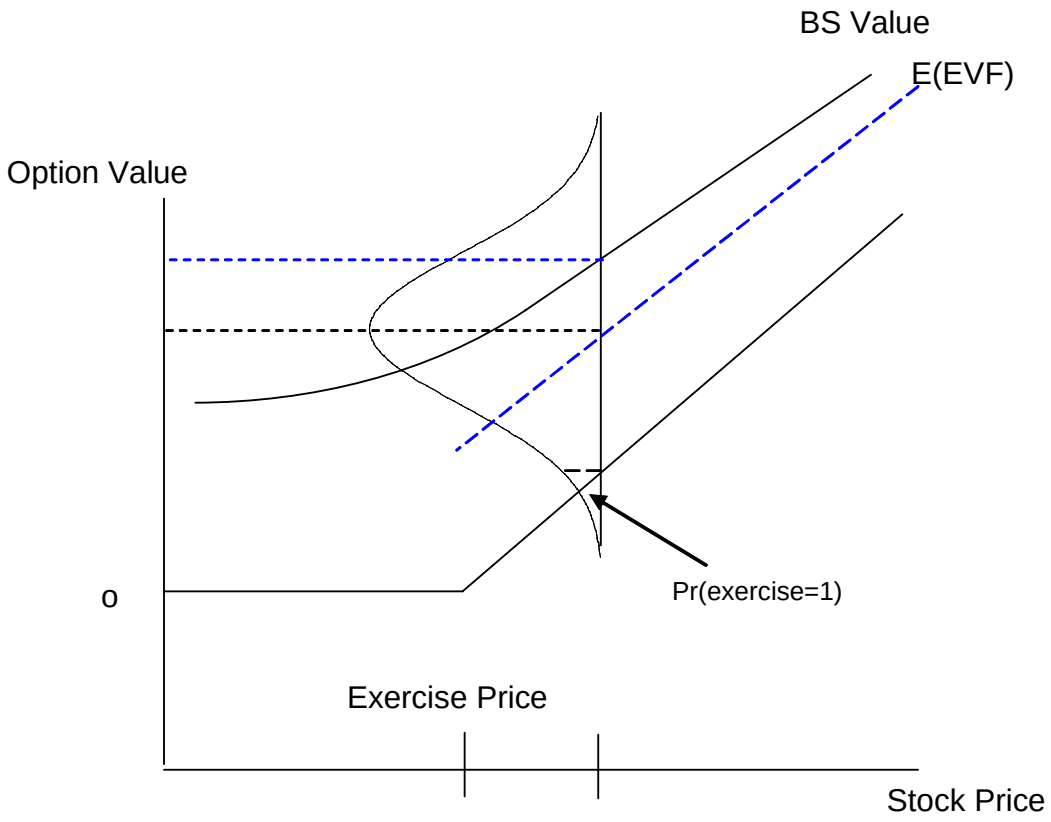


Figure 4b

The Exercise Probability In The Model Where The EVF is Truncated At The SP

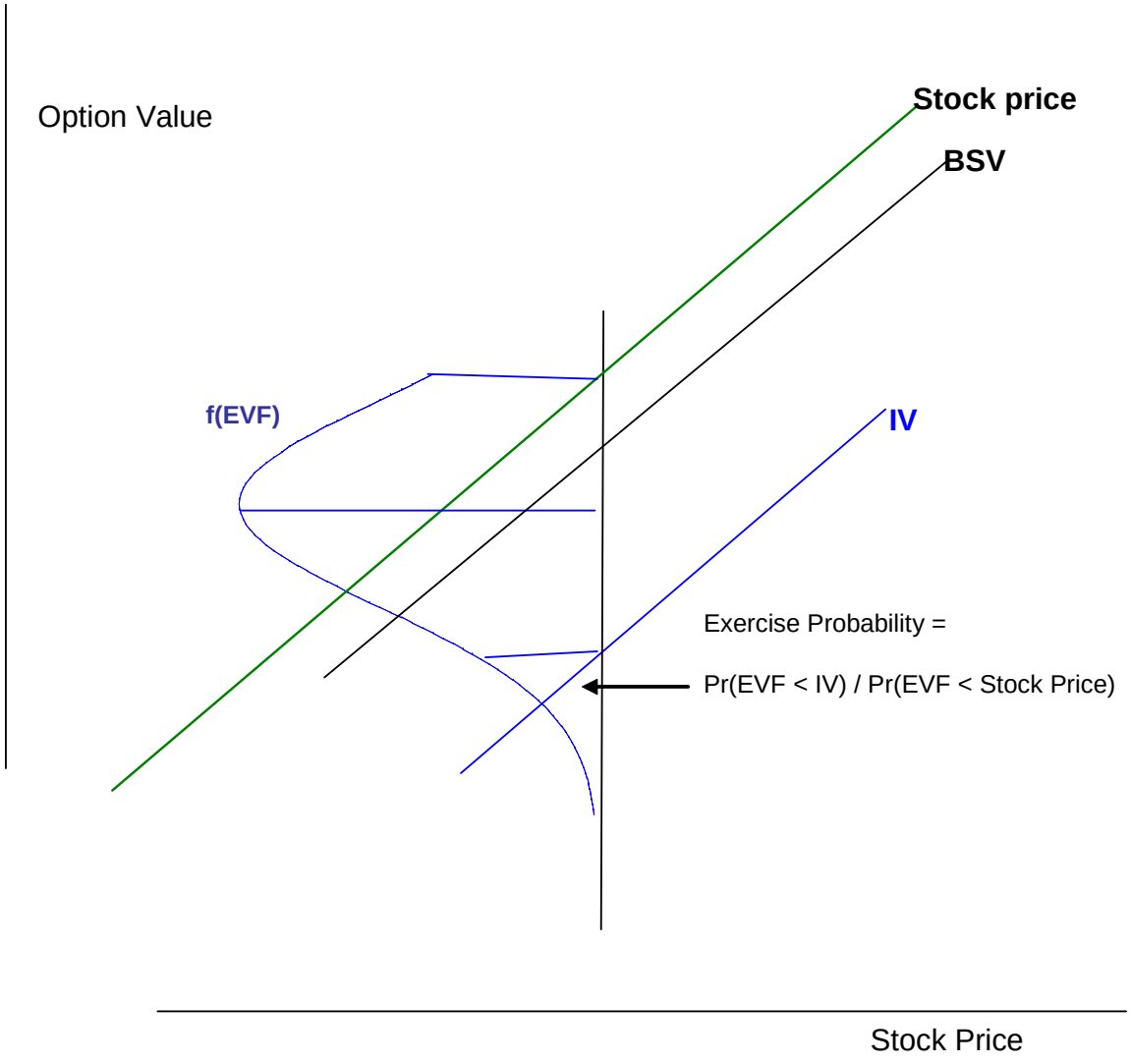


Figure 5a

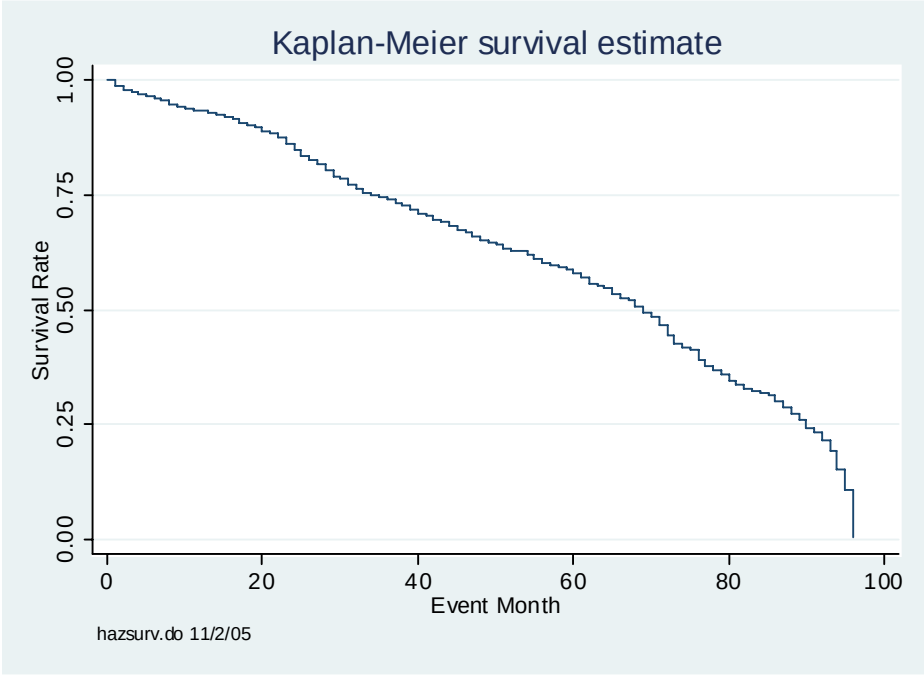


Figure 5b

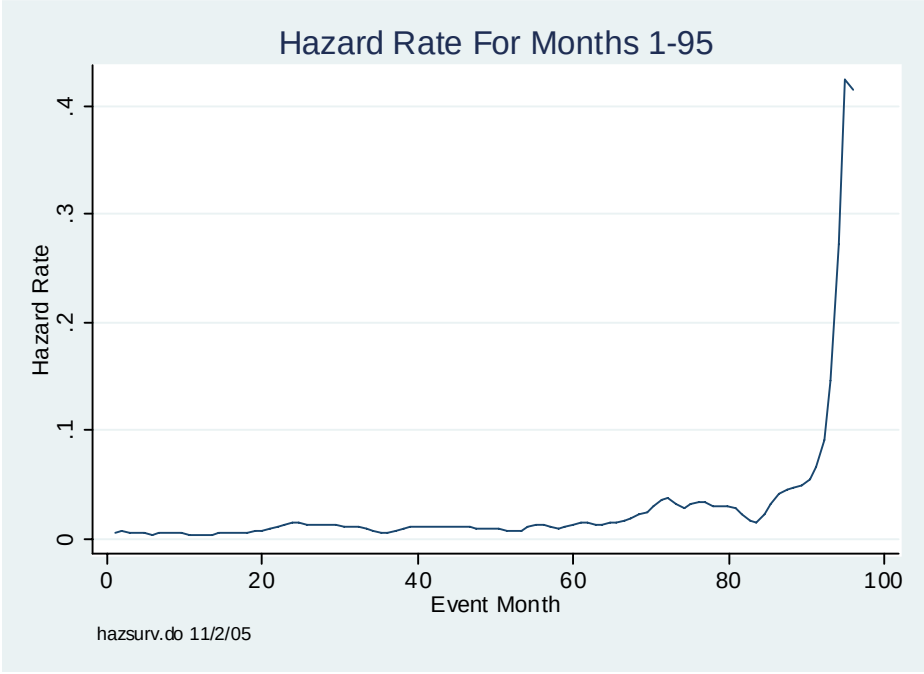


Figure 6

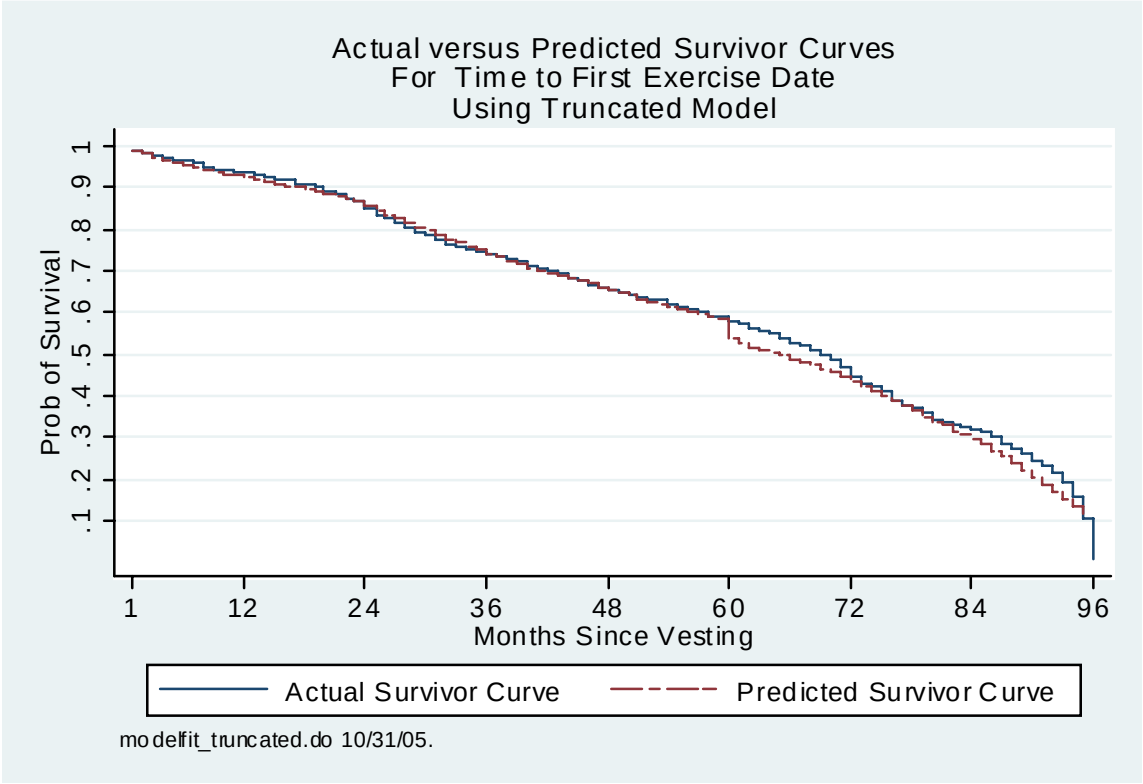

Actual versus Predicted Survivor Curves
For Time to First Exercise Date
Using Truncated Model
Prob of Survival
.1 .2 .3 .4 .5 .6 .7 .8 .9 1
1 12 24 36 48 60 72 84 96
Months Since Vesting
Actual Survivor Curve
Predicted Survivor Curve
modelfit_truncated.do 10/31/05.

Figure 7

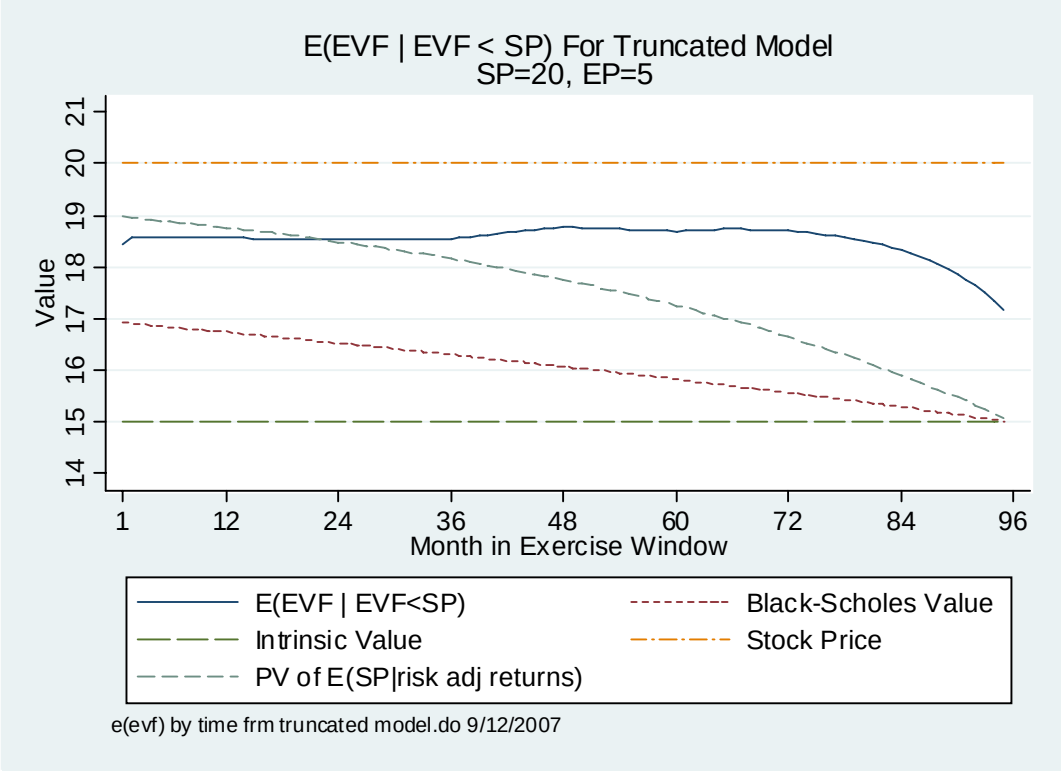
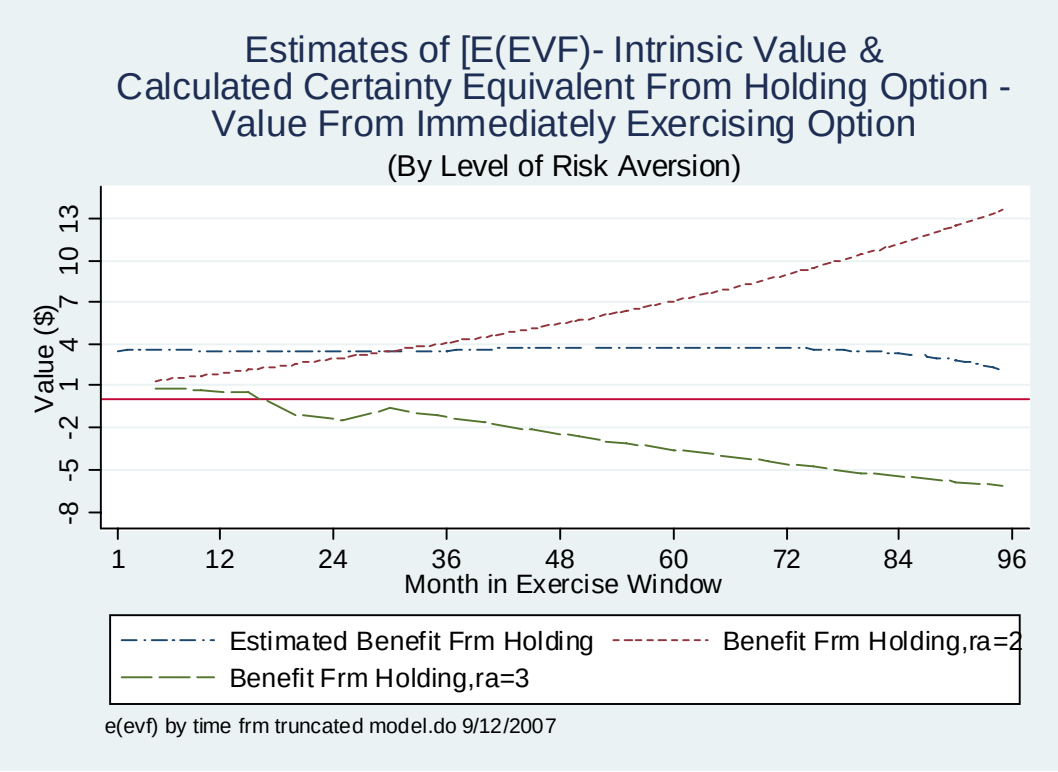

E(EVF | EVF < SP) For Truncated Model
SP=20, EP=5
Value
14
15
16
17
18
19
20
21
1
12
24
36
48
60
72
84
96
Month in Exercise Window
E(EVF | EVF<SP)
Intrinsic Value
PV of E(SP|risk adj returns)
Black-Scholes Value
Stock Price
e(evf) by time frm truncated model.do 9/12/2007

Figure 8


Estimates of [E(EVF)- Intrinsic Value &
Calculated Certainty Equivalent From Holding Option -
Value From Immediately Exercising Option
(By Level of Risk Aversion)
Value ($)
-8
-5
-2
1
4
7
10
13
1
12
24
36
48
60
72
84
96
Month in Exercise Window
Estimated Benefit Frm Holding
Benefit Frm Holding,ra=2
Benefit Frm Holding,ra=3
e(evf) by time frm truncated model.do 9/12/2007