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EMPLOYEE STOCK OPTIONS EXERCISES: AN EMPIRICAL ANALYSIS

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Employee Stock Options Exercises: An Empirical Analysis*

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Introduction

This paper documents the exercise behavior of employees who hold non-transferable long-term options on the stock of their employer. We report patterns in exercise behavior found in thedetailed grant and exercise records of seven corporations. Our data span the last decade and cover more than 40,000 employees. Understanding employee exercise behavior is essential to resolving the debate over the valuation of employee stock options in corporate financial statements.

Over the last decade, the importance of stock options in employee compensation packages has increased markedly.[1] Reasons for the popularity of options include the absence of a charge against accounting income for most option compensation, favorable tax treatment and the positive incentive effects of linking employee compensation to share price.

In response to perceived inconsistencies between accounting for employee stock options and other forms of compensation and the resulting problems in comparing earnings across firms with different compensation strategies, the FASB proposed a change in accounting for stock options. The change would require the recognition of an expense in the income statement based on an estimate of the options' cost to the employer corporation. Reaction was dramatic and often negative. Beyond decrying the lack of relevance and reliability in the resulting financial statements, opponents cite the proposed standard's potential effect on firms' willingness to issue employee options, the viability of emerging companies, the welfare of employees and, in the extreme, the competitiveness of US firms in world markets.

Many of the accounting issues raised in response to the exposure draft hinge on the actual exercise practices of employees who own options. Despite the potential importance of employee stock options to earnings under the proposed rules, little is known about option programs or employee exercise decisions. Principally, the lack of research follows from the lack of publicly available data on options for employees other than top executives. In this study, we provide descriptive evidence on option programs and exercise history for six companies, one large industrial company, one large high-

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1 See, for example, Coopers and Lybrand (1993).

technology company, one medium financial services company and three small high-technology corporations which recently began trading publicly. Our study is based on detailed data on employees, option grants, and exercise. Our goal in considering a small sample of companies is to provide descriptive detail which could be lost in aggregation. The choice of very dissimilar companies permits comparison across a range of environments.

The evidence in this study should be of interest to the FASB in its deliberations because it bears directly on the economic cost to the corporation of issuing options. As discussed in more detail in the next section, the current FASB proposal is based on option pricing models that were developed to value publicly traded options. As many commentators have noted, employee stock options (ESOs) differ from publicly traded options (TSOs) because ESOs cannot be sold by the employees who hold them. From a valuation perspective, the effect of this difference between TSOs and ESOs hinges on the effect of non-transferability on exercise decisions. Empirical evidence from option exercise is central to issues like whether valuation can be estimated with sufficient reliability to be recognized on the income statement, what valuation approach should be used and what underlying assumptions should be made in valuing options. Further, once requirements have been established, evidence on exercise practice will be important to corporations in deciding what value to assign to options for financial reporting purposes.

Evidence on the implications of exercise practice for ESO valuation is also important in contexts other than the FASB's activities. The SEC requires that proxies issued since 1993 include the value of options granted to the five most highly compensated employees. To date much of the valuation has been based on the Black-Scholes formula. However, the same issues that face corporations in complying with the FASB proposal are also present with the SEC requirements.[2] Further, corporations and compensation consulting firms also estimate stock option value for internal decision-making purposes. Again, an understanding of employee exercise patterns is necessary for accurate estimation.

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2 The SEC disclosure requirements include descriptive data on options outstanding in addition to estimates of option values so that investors can assess the value of options outstanding for themselves. However, knowledge of option exercise patterns is necessary for such estimation.

Beyond the implications for valuation, the research has potential implications for our understanding of compensation more generally. One often-cited motivation for increased use of stock options is their effect on employee incentives. However, the incentive effects depend on when the options are exercised and whether the employee retains share ownership. If employees generally exercise options for cash immediately on the vest date, the incentive effects are clearly different than if they hold them until expiration, especially since most options have long lives (e.g., ten years) but vest relatively early. An analysis of actual exercise policy provides information useful in anticipating the effects of a given option grant, in designing optimal future option grants and in anticipating the likely effect were option use to decrease as a result of the FASB (or other) action.

Finally, the data provide the opportunity to assess the effects of taxation on exercise decisions. Previous research provides evidence on the importance of taxation on corporate income shifting over time. Similar incentives exist for shifting by individuals around changes in tax regulations through option exercise decisions. Anticipated changes in tax regulation during 1986 and 1992 provided incentives to shift option exercise between periods. In on-going research, we are investigating the importance of tax-based incentives to exercise decisions.

In the next section, we discuss stock options, the FASB's proposal, and reaction to it in more detail. Next, we present the issues addressed in this paper. While the paper is primarily descriptive, existing theoretical and empirical research provides guidance as to the likely effects to be observed in the data. In the third section, we discuss the data used in the study and, in the fourth section, present the results. Finally, we present conclusions and extensions.

Background

On June 30, 1993, the FASB issued an Exposure Draft of a Proposed Statement of Financial Accounting Standards, "Accounting for Stock-based Compensation." In understanding current accounting under Accounting Principles Board Opinion No. 25 (APB 25), Accounting for Stock Issued to Employees, and the changes proposed in the Exposure Draft, it is useful to differentiate between fixed stock options and variable stock options. With

fixed stock option plans terms are known at the grant date and a strike price, expiration date and vesting dates are generally specified at the grant. With variable stock option plans, terms like the number of shares to be issued and the strike price are not known at the grant date and are determined by events which occur after the grant date (like performance).

Under APB 25, compensation expense associated with issuing options is determined on the measurement date, the date at which the terms of the option (number of shares to be issued and strike price) are known. Compensation expense is the difference between the market price of the stock and the strike price on the measurement date. For fixed options, therefore, the measurement date is generally the grant date and, as long as the strike price is no less than the market price (i.e., the option is at or out of the money), no compensation expense is recognized. For variable options, on the other hand, the measurement date is the date on which the terms become known (generally the vest or expiration date) and, because the strike price may not be greater than or equal to the market price at the time, compensation expense must often be recognized. In practice, variable option plans are relatively rare, a fact which many have attributed to their accounting treatment.[3]

The most controversial aspect of the current proposal is a requirement to recognize as compensation expense the value of fixed stock options issued to employees based on an option pricing formula. The new requirements are based on the argument that:

1. Employee stock options have value,
2. The value of employee stock options is reasonably estimable,
3. The value of stock options represents compensation, and
4. Compensation expense should be recognized in the income statement.

The method used to estimate the value of stock options would be a modified version of the Black-Scholes formula. Because the FASB recognized that

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3 Consistent with that notion, compensation consultants have begun designing variable ESOs in anticipation of the FASB's proposed changes in accounting for ESOs. Variable ESOs will be relatively more attractive under the proposed rules because the compensation cost of fixed ESOs will increase.

ESOs are often exercised before the expiration date, the term of the option would be the expected exercise date rather than the option term. To the extent that the actual exercise pattern differed from expectations, compensation expense would later be adjusted to the actual life of the option.

Opposition to the standard has been pronounced. Major issues raised by critics include:

1. The potential effects of the changes on companies willingness to issue options and, ultimately, on the competitiveness of US companies,
2. The difficulty in accurately measuring the cost of the options to the company at the grant date,
3. Conceptual issues as to whether an option grant represents and expense or a capital transaction, and
4. The lack of clearly identified demand for including option value on the income statement (as opposed to disclosure in the notes).

To date relatively little direct evidence has been brought to bear on these issues. Most evidence to date has been on the magnitude of the adjustment to compensation expense as a percentage of net income. One recent study is Coopers and Lybrand (1993) which quantifies the likely effect of the pronouncements (and the sensitivity to changes in assumptions) on 27 emerging and mature companies to provide evidence on the likely magnitude of the effect of the proposal on companies' net income and shareholders' equity.[4] Their results suggest that the proposal would have had substantial effect on reported profitability in the period studied. The estimated average reduction in net income after the phase-in period would have been 3.4% for mature companies and 26.5% for emerging companies. Further, their evidence suggests that the valuation of options is sensitive to the underlying assumptions, particularly the term of the option and the expected stock price volatility, both of which may be difficult to estimate.

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4 Related research includes Foster, Koogler and Vickrey (1991) who estimate executive option value as a percentage of 1986 operating income for a sample of companies based on data from proxy statements. We focus on the Coopers and Lybrand (1993) results because they include all employee stock options issued by the sample companies and are based on more recent data.

Our paper takes a different approach, focusing not on the significance of the resulting effects relative to net income, but on describing the actual exercise patterns. Our attempt to characterize exercise patterns reflects concern expressed about the difficulty in valuing stock options. There are at least two issues. First, there is no public market for employee stock options to use in assessing the accuracy of option costs recorded on the income statement. ESO values cannot be directly inferred by observing prices. Moreover, the accuracy of potential option pricing formulas cannot be assessed by comparison to observed prices.

The FASB's proposal hinges in part on the assertion that "during the last 20 years mathematical models to estimate the fair value of options have been developed to meet the needs of investors" and that "software available for personal computers reduces the application of those models to a fill-in-the-blank exercise." However, the models cited were developed for publicly traded options and presume transferability of the option and a particular exercise schedule (generally exercise at expiration). Anecdotal evidence of actual exercise decisions suggests that the exercise policy for publicly traded options differs from the actual exercise policy for employee stock options. Without empirical evidence as to actual exercise practice, it is not clear that the assumptions underlying the valuation of traded stock options apply to employee stock options. While other models exist which take into account actual exercise practice (e.g., exercise as a function of time to expiration, market-to-strike price ratios and employee wealth), evidence on actual exercise patterns is necessary to evaluate the need for and best approach to alternate valuation approaches.

There has been some recent effort to value employee stock options. Huddart (1994) proposes an alternate approach to valuing employee stock options which explicitly incorporates the effects of inalienability and risk aversion on employee exercise decisions. In that model, as in the Black-Scholes formulation, risk neutral employees exercise options on non-dividend-paying stocks only at expiration. However, risk averse employees generally exercise options prior to expiration, even for stocks which pay no dividends. The intuition is that in certain price ranges (particularly when the market-to-strike ratio is large) employees prefer to exercise options in order to reinvest the proceeds in other assets. Employees would prefer not to have too large a portion of their wealth concentrated in options on their employer's

stock. The model is consistent with the received wisdom that employees generally exercise options well before expiration. Therefore, an option valuation formula (like the Modified Black-Scholes approach described by the FASB) based on exercise as a function of time alone is not descriptive. Incorporating the expected time to exercise into the analysis in the manner suggested in the exposure draft would result in a misvaluation of the underlying options by a potentially substantial amount because it does not reflect the decision rules used by employees.

Other factors are likely effect valuation as well. For example, Cuny (1993) argues that employees are more likely to remain with their current employer as the stock price rises. Since employee turnover is correlated with stock price movements, adjustments to valuation for turnover should capture these effects. Further, tax-based incentives, liquidity constraints and beliefs of future stock price movements held by individual employees are all likely to affect employee exercise decisions in ways which are not captured by simply adjusting the Black-Scholes model for expected exercise based either on past history or easily estimated anticipation of the future.

In this paper, our approach is primarily to describe the actual exercise activity that occurs and to attempt to relate it to potentially important factors suggested by theoretical research and intuition. While our results neither answer the question of whether option value should be expensed on the income statement (or disclosed in the notes) nor provide the most appropriate option valuation approach, they do provide indirect evidence on those issues by indicating the extent to which the assumptions underlying the proposed approach are consistent with observed behavior.

Data

Our analysis is based on option data for a sample of six companies which agreed to participate under conditions of confidentiality. All six companies issue stock options to a large number of employees. Table 1 provides descriptive data on the sample companies. Companies A-C are NYSE listed companies with 1992 market capitalization in excess of $1 billion, net income in excess of $50 million and more than 10,000 employees. Company A is diversified, Company B is an electronics company and Company C is in the financial services industry. All have been trading

publicly for at least a decade. Companies D-F are smaller companies in the computer industry which began trading publicly in the last decade and are included on the NASDAQ. All three had 1992 market capitalization of less than $1 billion, net income of less than $50 million and fewer than 10, 000 employees. Company G is an employee owned corporation. The stock of company G is traded only (i) among employees and (ii) between the coporate treasury and employees at a price established by formula. The market capitalization indicated by the formula price in 1992 is between $1 billion and $500 million. In 1992 net income was less than $50 million. Company G has more than 10,000 employees. Our sample includes a range of companies, which allows us to investigate the robustness of the results across a variety of settings. Further, the presence of two firms that recently went public allows us to investigate the issues for the subset of firms which has caused the greatest concern on the part of the many commentators—emerging high technology firms for whom a change in accounting requirements for options could have a significant effect on reported results and, allegedly, the continued use of option based compensation and capital markets access. Coopers and Lybrand (1993), for example, find in their sample that options as a percent of compensation and, hence, the implications of the proposed standard are much more substantial for emerging than for mature firms.

Because we believe that important differences may exist across companies, we present our results on an individual company basis and then present conclusions more generally.

Empirical Design

Our empirical analysis is designed to provide evidence on four primary questions:

1. To what extent are options exercised prior to maturity?
2. Assuming that significant exercise does occur prior to maturity, is it clustered around specific, predictable points during the option's life?
3. To what extent is exercise predictable based on past history or comparison across companies?

4. What factors other than time to exercise appear to be important determinants of exercise?

Our first set of analyses is a description of exercise patterns as a function of time to expiration. To the extent that exercise seems to cluster around certain dates and seems consistent across grants, time since grant may be an important determinant of exercise policy. Next we consider the relation between exercise and calendar time. To the extent that events occurring at the company level change incentives to exercise options, patterns should be evident in exercise activity as a function of calendar time. Finally, we examine exercise as a function of other factors including the market to strike ratio. If crossing a hurdle stock price level triggers exercise, that pattern should be evident in the relation between recent stock price movements and exercise.

Description of Options

The options for all six sample companies are fixed stock options, generally with strike price equal to the market price on the date of the grant. Therefore, under current accounting, no expense would have been recognized for the options issues. Company A issued non-qualified ten-year options that vest annually in increments of 25% over 3-4 years. Company B issued incentive stock options prior to 1986, but for most of the period issued only non-qualified options.[5] For Companies B and C, options included in the analysis are all ten-year options vesting ratably at 25% per year.[6] Companies D and E issued non-qualified stock options with somewhat more complex terms and vesting provisions. Company D issued ten-year options that vest monthly over four to five years. Company E issued ten-, six- and

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5 Incentive stock options differ from non-qualified options in their tax treatment. In general, incentive stock options provide no deduction for the employer but allow employees to defer gain recognition until the underlying stock is sold, at which time profits are taxed at capital gains rates. Non-qualified options provide a deduction for the employer at the exercise date for the difference between exercise and strike price and are recognized at ordinary income rates when exercised. While the tax differences may affect incentives to exercise options, the direction of the effect is not clear. In our empirical analysis, conclusions for the incentive stock options are consistent with those for the non-qualified stock options.

6 For comparability, a small number of options with other terms, issued primarily to non-US employees of Company B were excluded from the analysis. Also excluded for Company B are a small number of options with cliff vesting. Conclusions are not sensitive to their exclusion.

five-year options that vest over various schedules. Company F issued five year options which vest ratably over three to four years. Company G issued only five year options that vest annually in increments of 10% to 40% over four years.

Data on the employees granted options indicate option grants extended deep into the organization. For Companies A, B, C, D, E, F, and G, 14,832, 24,126, 608, 575, 729, 3,232, and employees, respectively, were granted options at some time during the period. Table 2, Panel A presents descriptive data on the grants for the sample companies. We do not have data on number of employees in the company on a continuous basis and therefore base analysis on number of employees at year-end. Taking the mean across years in the sample, the percentage of employees receiving options ranges from 0.8% for Company C to 70.2% for Company F. The other computer companies, D and E both also issue shares to a substantial percentage of employees, with medians of 32.4% and 55.2%, respectively. While it is difficult to disentangle the effect of industry from size, the relative high percentage for Company B, 9.2%, is consistent with a tendency for firms in high-technology industries to issue options to more employees.

Table 2, Panel A also presents data on the range of percentages of employees receiving options across years. There is a substantial differences on a year-by-year basis for most sample companies. Further, for the large companies A and C there is evidence of increasing use of options over time, with the percentage of employees receiving options increasing monotonically over the sample period.

Table 2, Panel B presents data on options granted in a given year as a percentage of options outstanding at year-end. The mean percentage ranges from 0.5% for Companies A and C to 8.6% for Company F. In general, the pattern across companies and over time is similar to that for percentage of employees receiving options. Since options are typically outstanding for several years, the data suggest that options outstanding are a large fraction of shares outstanding, particularly for Companies D-F.

Table 2, Panel C presents descriptive evidence on the number of grants during a year by company, data which are important for structuring the empirical tests. The number of grants per year illustrate the companies policy of grant distribution. At the extremes, Company B has a general option grant once per year, with additional grants in some years based on merit, while

Company F issues options almost daily in some years based on employee anniversary and promotion dates. Because strike price is generally equal to market price at issuance and vesting and expiration are based on grant date, companies which issue options more frequently have a wider variety of options outstanding at any point in time.

Table 2 also presents data on the number of options granted on a grant date, the number of employees receiving options and the number of options per employee. The data suggest that most grants represent a substantial number of shares granted to a large number of employees, with each employee receiving options on a relatively large number of shares. However, there is also a substantial range across companies. In particular, Companies A, D and F often grant options to only a few employees on a given grant date. The number of options per employee across all companies is quite tightly clustered for all companies based on the median and tenth and ninetieth percentiles, but each company's distribution has a substantial right tail: the maximum value is at least 80 times as large as the median value.

Univariate Analysis of Exercise Activity

Table 3 presents data on exercise activity by employee. In general, employees exercise a significant percentage of their shares owned at a time. The median percentage exercised ranges from 13% for Company E to 100% for Company G. Further, for all companies but Company E, the ninetieth percentile of exercise is for 100% of shares granted. It should be noted, however, the data are potentially biased downward because the sample includes a significant number of options which had not expired as of the end of the sample period.

Table 3 also presents data on the percentage of life elapsed at exercise. The median ranges from 21% for Company F to 92% for Company D, suggesting that an assumption that employees exercise primarily at expiration is not supported by the data. Data for the tenth percentile range from 5% to 39% suggesting that a substantial proportion of employees exercise within the first year or two. Further, the ninetieth percentile ranges from 39% of option life for Company E to 99% for Company G.

Additional evidence on exercise patterns is available in Figure 1 which plots frequency of exercise as a function of exercise percentage and life of the

option on an employee/grant basis. The distribution across exercise percentages suggests that most exercise takes place at 25%, 50%, 75% or 100% of shares granted. Comparing across the life of the option, the maximum points for 25% exercise occurs in the first six months of the second year of option life, for 50% exercise occurs in the first six months of the third year of option life, for 75% exercise occurs in the first six months of the fourth year of option life, and for 100% exercise occurs in the first half of the fifth and sixth years of option life. The highest peak occurs at the beginning of the second year of option life and 25% of shares granted. This may reflect a tendency for a significant subset of employees to exercise immediately on the first vesting anniversary. The other peaks suggest that some employees wait past this anniversary, but then exercise all available options at a later vesting date. Further, the graph confirms that much of exercise takes place well before expiration.

The left-hand panel of figures 2a–g present cumulative monthly exercise as a percentage of shares issued, averaged over grants made by Companies A–G in a particular year as a function of time since grant. In general, the conclusions for average grant exercise policy are similar to those from Figure 1. For Company A, approximately fifty percent of options granted were exercised in the first half of the option life. That fact is striking given that options vest annually over the first three to four years of the option life. The fact that option exercise is generally spread over time also has implications for the valuation for valuation. As discussed in Hemmer, Matsunaga and Shevlin (1994), the option pricing model suggested in the FASB Exposure Draft assumes that all exercise occurs at the expected exercise date. To the extent that exercise is spread over time, the proposal ignores the concavity of the valuation function with respect to time to expiration and, hence, assigns too high a value to options.

For Company B and C, exercise occurs somewhat later but still generally takes place well before expiration. Analysis of Company D and E is limited by the facts that the company began issuing options late in the sample period and Company D issues options with a variety of lives. Nevertheless, the evidence for the first three or four years suggests as much of a tendency toward early exercise as for the more established companies. Company F issues five year options and, for many grants, exercise appears to occur relatively early in the options life.

In addition to providing evidence on the average time to exercise, the figures also provide insight into the estimability of option exercise based on past experience. The Exposure Draft suggests options be valued based on their expected time to exercise, with a catch-up adjustment later in the options life to adjust option life based on actual exercise experience. To the extent that exercise is difficult to predict ex ante, the resulting valuation estimates (and the charge against net income) will be unreliable at the time the options are granted and the later catch-up adjustment will tend to be large and increase the variability of reported net income.

The dispersion across grant/years in Figure 2 suggests that exercise patterns can vary substantially. Even for the largest company, examining the time at which the median option from a grant is exercised (i.e., cumulative option exercise reaches fifty percent), average option life varies from approximately four years to almost seven years. The variability for the other large companies is comparable and, for the smaller companies, even greater. In addition, the differences across companies suggest that using one company as a basis for another company's expected exercise experience (as has been suggested, for example, with newly public companies) is not likely to improve estimates substantially. Finally, the dispersion across grants suggests that, absent more clear guidance as to estimating expected lives, a potentially wide range of times to maturity could be justified. Estimates that later proved high of low would be corrected by the catch-up adjustment under the current proposal, reducing incentives to underestimate the life of the option (and, hence, compensation expense at the grant date). However, were the catch-up adjustment to be dropped (as many commentators have suggested) incentives to choose a low expected option life to maximize net income would exist.

The fact that exercise patterns appear to differ substantially across companies and grants within a company begs the question: What factors appear to determine exercise activity? One obvious possibility is that factors that are company-wide (e.g., stock price history) or economy-wide (e.g., changes in tax regulations or macro-economic conditions) might influence exercise policy. An approach to isolating those types of effects is to examine the data in calendar time (as opposed to time elapsed since the grant date). The right-hand panels of figures 2a–g present cumulative plots of shares exercised as a percentage of shares granted as a function of calendar time, along with a plot of the stock price path over the options' lives. Starting with

figure 2a, there is evidence of clustering in exercise across grants at detectable points in time. In particular, there are months in which increased exercise activity appears to occur for most grant/years simultaneously.

Further, those months appear to coincide with periods of substantial stock returns. This result is not sensitive to exclusion of options with market to strike ratios of less than one, suggesting that even for options in the money, stock price movements are an important determinant of exercise.

This observation stands in sharp contrast to what we would expect to see for TSOs. For TSOs, exercise before expiration is sub-optimal and is not generally a function of the market-to-strike ratio or recent share price movements. That result obtains because a publicly traded option's market price is greater than the difference between the market value of the stock and the strike value of the option. In the case of employee stock options, risk aversion limits an employee's willingness to hold an option that is deep in the money. In these cases, non-transferability precipitates exercise. Therefore, exercise is likely to be a function of the market-to-strike ratio. Further, option exercise is likely to be a function of recent stock price movement because exercise is likely to take place when stock price first crosses a threshold market to exercise ratio.

The patterns for the other companies in figures 2b–f lead to similar conclusions. Movements in stock price seem clearly important in determining exercise. For example, figure 2b suggests substantial clustering of option grants in the last two years of the sample period, a period of substantial stock price appreciation. Similarly, clustering in exercise activity is observed for the other sample companies.

Figure 2g stands in sharp contrast to figures 2a to 2f. Most employees at Company G wait until just before expiration to exercise the options they hold. The exercise pattern for options granted on different dates at Company G are highly correlated. Also, exercise at Company G on average occurs much closer to the expiration date of the stock option than at any other company. Huddart and Lang (1994) and Kulatilaka and Marcus (1994) argue that increases in stock price volatility lead to earlier exercise. Since Company G's stock price is substantially less volatile than the stock price of any other company, the finding that exercise occurs much later at company G is consistent with the predictions of the analytical models.

Regression Analysis

The preceding analysis suggests that both time to expiration and stock price movements may be important determinants of employee exercise activity. To address those issues formally, we conduct regressions of the percent of options exercised as a function of various explanatory variables including stock price measures and time to expiration. The unit of observation is a grant/month and the dependent variable is percentage of shares exercised for a specific grant in a given month divided by the number of shares originally issued in that grant. Because grants vary substantially, both within and across companies, in the number of employees who received them and the total number of shares issued, small grants will tend to have a higher variance in percent exercised in a given month than large grants. Therefore, we estimate weighted least squares regressions with weights based on the number of employees receiving shares. By-company results weighting based on shares issued are very similar, but pooling across companies is hampered by differences in shares. We also estimated ordinary least squares regressions excluding the smallest grants with similar results.

In terms of explanatory variables, we consider four returns variables and two variables based on the market to strike ratio:

1. Monthly return ending fifteen days prior to the month
2. Return over the fifteen days prior to the month
3. Return over the month
4. Return for the following month
5. Market to strike ratio on the first day of the month
6. Market to strike ratio squared

Use of these stock price measures is motivated by studies like Huddart (1994) who suggests that, given risk aversion, exercise will be a function of market to strike ratios, with risk averse employees exercising when some threshold market to strike ratio is reached. Assuming that the sample of employees have a distribution of risk tolerances, one would expect exercise to generally increase in market to strike ratio. Further, the relation would probably be nonlinear with little exercise at market to strike ratio slightly above one as the most risk averse employees exercise, increasing more rapidly as one approaches the market to strike ratio for the average employee and then leveling off for high market to strike ratios. In addition, recent return is lagged returns are likely to be associated with exercise since, loosely speaking, exercise will tend to occur at the time a market to strike ratio threshold is first crossed. Inclusion of future returns allows us to examine whether exercise is primarily a function of knowledge about the future rather than a reaction to past performance.

We also include three other variables:

7. Percentage of grant available
8. Years of life remaining
9. Standard deviation of return.

Percentage of grant available captures the extent to which the grant was not fully vested and the cumulative effect of past exercise. Percentage of life remaining captures the fact that as expiration approaches, the value of the option component decreases, increasing the tendency to exercise for a given market to strike ratio. Finally, the standard deviation of returns captures the

notion that an increase in price variability may cause increased exercise by risk averse employees.

Regression results are included in table 4, beginning with pooled analysis and then company by company. Observations with market to strike ratios less than one and cases in which grants have been fully exercised are excluded. Rank regression results are included in addition to parametric results as some of the relations may be nonlinear and distributional assumptions underlying ordinary least squares may be violated. Conclusions are generally consistent across companies and between ranked and ordinary least squares regressions. In terms of the returns variables, recent returns are strongly positively associated with exercise, particularly contemporaneous returns. The relation is negative for the longer lagged returns which, together with the positive association for contemporaneous returns, suggests that exercise activity is greatest in periods in which the stock price is rebounding from a previous fall. There is little evidence of a negative relation between exercise and future returns, suggesting that exercise does not occur primarily in anticipation of future returns.

The relation with market to strike ratio is positive, suggesting more exercise when market to strike ratios are high even after controlling for recent returns.[7] However, the coefficient on the market to strike ratio squared is negative, suggesting that the relation is increasing, but at a decreasing rate.[8] The coefficient on percentage of grant available is generally positive, suggesting that more exercise occurs when more options are available. The coefficient on percentage of life remaining varies across companies, suggesting that the relation between option life and exercise may be more complex than we have captured. Finally, the standard deviation of returns is generally negative, providing little evidence that increased share price variability increases exercise activity.

The regression R^2's range from 0.05 to 0.46 for the parametric weighted least squares specification (0.08 for the pooled regression) and from 0.17 to 0.67

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[7] Significance levels of coefficient estimates should be viewed with caution because of potential violations of independence across observations. We are currently investigating the extent to which this is an issue.

[8] A problem with the quadratic formulation for market to strike is that the relation can become negative for high market to strike ratios. Based on the coefficient estimates, that would occur for market to strike ratios greater than seven. We are currently considering alternate specifications.

for the rank regression (0.28 for the pooled regression) suggesting that, while a significant proportion of the variation is explained, much of it remains.

Extensions

Our analysis to date is clearly limited in the analysis and variables we consider and the conclusions that we draw and is at the work in process stage. We are currently expanding the analysis in several ways. First, we are considering alternate empirical specifications. The regressions are likely to suffer from a variety of econometric issues, several of which were discussed earlier. In addition, the unit of observation used above, the grant month, is only one possible measure. Perhaps a measure computed at the employee level is more appropriate. That would allow us to explicitly incorporate knowledge of employee characteristics (e.g., salary and rank data) into the analysis.

Second, we are considering other variables to include in the analysis including some that capture tax considerations. For example, substantial tax law changes occurred during the sample period which may have changed incentives to exercise. In addition, we have not incorporated variables like vesting month which appeared to be important in figure 1. Finally, there may be (and a cursory examination suggests that there are) seasonalities in the data related to factors like liquidity needs which have not been incorporated.

Third, we are expanding the sample to include additional companies as more data becomes available. While we will probably never have access to a large sample of companies, additional data will enhance generalizability of the results.

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Table 1: Descriptive Statistics on Sample Companies and Option Terms

Company	A	B	C	D	E	F	G
Panel A: Company description							
Industry	Diversified	Electronics	Financial	Computer	Computer	Computer	Service
Market Capitalized	> $50B	$10 – 50B	$1 – 10B	< $1B	< $1B	< $1B	< $1B
Employees	> 100K	50 – 100K	10 – 50K	< 1K	< 1K	1 – 10K	10 – 50K
Net Income	> $1B	$.5 – 1B	$.05 – .5B	< $.05B	< $.05B	< $.05B	< $.05B
Exchange	NYSE	NYSE	NYSE	NASDAQ	NASDAQ	NASDAQ	unlisted
Panel B: Option terms							
Strike	= Market	= Market	= Market	= Market	= Market	= Market	= Market
Term (Years)	10	10	10	10, 6, & 5	10	5	5
Vesting Schedule	straight line	straight line	straight line	straight line	straight line	straight line	straight line or sum of years' digits
Vesting	Anniversaries	Annually	Annually	Annually	Monthly	Various	Annually	Annually
Years to Full Vest	3 to 4	4	4	4 to 5	4 to 5	3 to 4	4

Notes: Data in Panel A are from Compustat for fiscal year 1992.

Table 2: Descriptive Statistics on Option Grants

Company	A	B	C	D	E	F	G
Panel A: Percentage of employees who receive options by year (sample year in parentheses)							
Minimum Year	0.1 (1)	4.5 (1)	0.0 (1)	3.4 (6)	48.5 (2)	31.1 (11)	15.7(1)
Median Year	0.4 (5)	9.1 (5)	0.6 (6)	21.5 (5)	59.4 (2.5)	82.0 (1)	23.9(8)
Maximum Year	3.3 (9)	15.1 (6)	1.9 (11)	100.0 (4)	62.5 (4)	100.0 (3)	30.5(10)
1992	3.3 (9)	8.5 (8)	1.9 (11)	4.3 (9)	62.5 (4)	31.1 (11)	29.5(12)
Mean	1.1	9.2	0.8	32.4	55.2	70.2	22.8
Panel B: Mean number of options granted per year as a percent of shares outstanding (sample year in parentheses)							
Minimum Year	0.2 (1)	0.4 (1)	0.0 (1)	1.0 (7)	2.7 (2)	3.1 (4)	3.5 (6)
Median Year	0.5 (6)	0.9 (6)	0.6 (6.5)	4.5 (3)	5.2 (3.5)	6.0 (10)	5.1 (4)
Maximum Year	0.8 (9)	2.3 (6)	1.1 (11)	21.3 (1)	14.8 (1)	32.4 (9)	7.8 (12)
1992	0.8 (9)	0.9 (8)	0.9 (12)	1.4 (10)	6.5 (4)	4.5 (11)	6.6 (13)
Mean	0.5	1.1	0.5	7.3	7.0	8.6	5.1
Panel C: Number of grants per year							
Minimum Year	4.0	1.0	1.0	5.0	6	1	3
Median Year	9.0	1.0	1.0	10.0	7	110	7
Maximum Year	9.0	3.0	4.0	15.0	7	224	12
Mean	8.0	1.5	1.6	9.9	6.7	103.6	6.3

Table 2: Descriptive Statistics on Option Grants (continued)

Company	A	B	C	D	E	F	G
Panel D: Number of options granted on a grant date (thousands)							
Minimum	2	11	1	0	1	0	1
10%	3	313	4	2	19	0	13
Median	11	1,944	33	12	59	2	275
90%	2,109	2,552	783	179	205	17	678
Maximum	4,408	3,471	840	1,898	1,068	23,987	2,052
Mean	507	1,787	231	70	110	17	325
Observations	72	12	23	119	40	1,450	152
Panel E: Number of employees receiving options on a grant date							
Minimum	1	17	1	1	1	1	1
10%	1	100	1	1	5	1	1
Median	3	6,958	7	3	17	2	67
90%	518	7,941	272	44	52	13	872
Maximum	7,005	11,824	387	364	287	3,225	1,743
Mean	390	6,020	88	16	30	13	152
Panel F: Number of options granted per employee							
Minimum	100	25	200	8	100	1	15
10%	500	100	1,000	375	100	50	50
Median	500	175	1,696	1,500	1,800	379	500
90%	3,000	500	4,848	9,000	8,500	2,676	2,000
Maximum	65,000	65,000	62,200	120,000	150,000	300,000	400,000
Mean	1,301	297	2,626	4,348	2,626	1,300	1,204

Notes: Data in Panel A are computed as the number of employees receiving options during a sample year divided by total employees as of the end of the year as reported in Compustat. Numbers in parentheses represent the year in the sample for that company for which the value obtained (e.g., for a company in the sample from 1984 –1992, 1984 is year 1 and 1992 is year 9). Data in Panel B are computed as the number of option shares granted during the sample year divided by total shares outstanding as of year end as reported in Compustat. Data in Panel C are based on the number of option grants per year. Data in Panels D–F are based on the empirical distribution of all option grants in the sample.

Table 3: Exercise Activity by Employee

Company	A	B	C	D	E	F	G
Panel A: Fraction of options granted that are exercised by an employee at one time							
10%	0.25	0.25	0.20	0.05	0.02	0.24	0.14
Median	0.30	0.63	0.40	0.31	0.13	0.50	1.00
90%	1.00	1.00	1.00	1.00	0.40	1.00	1.00
Mean	0.45	0.64	0.48	0.41	0.18	0.55	0.72
Panel B: Fraction of life elapsed at the time of exercise (all observations)							
10%	0.11	0.13	0.11	0.17	0.09	0.05	0.39
Median	0.27	0.35	0.31	0.38	0.22	0.21	0.92
90%	0.51	0.71	0.64	0.67	0.39	0.60	0.99
Mean	0.30	0.40	0.35	0.40	0.23	0.26	0.79
Panel C: Fraction of life elapsed at the time of exercise (expired options only)							
10%			0.21	0.24		0.20	0.49
Median			0.68	0.46		0.48	0.96
90%			0.99	0.83		0.83	1.00
Mean			0.64	0.49		0.51	0.84

Notes: Data are based on employee-by-employee exercise activity. Panel A presents the percentage of options granted that an employee exercises at one time, Panel B presents the fraction of the life elapsed at exercise for all options, and Panel C presents the fraction of the life elapsed at exercise for only those options whose expiration date had passed by the end of the sample period.

Table 4: Regression of Percentage of Options Exercised on Returns, Market-to-strike, Options Available, Time, and Volatility

(coefficients and standard deviations x 1,000)

	Intcp	R–3	R–2	R–1	R0	R1	R2	MTS	MTS2	Vest	PGA	LL	V–1	V–2	R2	n
Public																
Tobit	-15.078	-10.792	-16.079	27.974	45.082	13.610	3.082	14.784	-2.159	2.437	17.371	-0.149	-2.287	-7.139		22072
Std. Err.	0.026	0.026	0.038	0.041	0.038	0.041	0.028	0.015	0.003	0.054	0.014	0.001	0.019	0.019		
OLS	-10.358	-9.966	-17.435	26.845	41.665	11.931	2.915	11.969	-1.712	3.062	13.392	-0.382	0.910	-2.762	0.2084	22072
Std. Err.	0.716	0.727	1.039	1.136	1.048	1.119	0.761	0.420	0.070	1.529	0.398	0.036	0.509	0.496		
Rank	17148000.000	-22.986	-11.964	8.738	48.542	23.281	4.349	89.989		-197.847	141.463	126.406	-73.178	-96.180	0.3005	22072
Std. Err.	162858.675	3.631	3.742	3.470	3.673	3.587	3.843	3.886		5.439	3.198	4.332	4.336	4.083		
Company A																
Tobit	-29.533	-12.931	-18.033	87.857	86.694	52.331	-10.352	39.852	-9.942	24.910	13.915	-0.580	-6.563	-0.596		3450
Std. Err.	0.163	0.113	0.164	0.147	0.153	0.154	0.122	0.105	0.026	0.103	0.048	0.010	0.107	0.095		
OLS	-23.549	-10.698	-15.013	83.772	75.686	50.419	-7.351	32.655	-8.123	20.673	14.036	-0.693	1.450	0.978	0.3144	3450
Std. Err.	4.997	3.513	5.124	4.599	4.721	4.844	3.791	3.170	0.784	3.217	1.487	0.299	2.896	2.795		
Rank	1844081.848	-9.858	-52.268	37.770	109.123	43.834	-8.619	192.468		62.959	161.684	169.662	-23.590	-65.181	0.2681	3450
Std. Err.	82133.472	6.673	6.719	5.998	6.318	6.492	7.182	17.096		15.785	8.938	17.893	7.814	8.006		
Company B																
Tobit	-24.596	-10.182	-28.162	38.210	59.221	15.332	1.935	28.358	-6.297	-1.432	9.224	-0.899	10.285	4.980		637
Std. Err.	0.034	0.021	0.033	0.033	0.032	0.033	0.023	0.031	0.008	0.040	0.012	0.001	0.019	0.017		
OLS	-24.394	-10.204	-28.187	38.279	59.023	15.150	1.917	28.182	-6.258	-1.425	9.222	-0.899	10.239	4.981	0.4572	637
Std. Err.	4.962	3.042	4.930	4.818	4.789	4.920	3.364	4.506	1.197	5.971	1.800	0.177	2.808	2.569		
Rank	84545.892	-128.748	-157.155	174.851	351.777	95.184	-51.192	365.878		57.239	337.561	-147.624	40.599	-6.340	0.6732	637
Std. Err.	31884.063	19.430	20.202	19.689	19.781	19.793	20.412	21.412		54.377	26.004	25.976	21.405	19.486		

	Intcp	R–3	R–2	R–1	R0	R1	R2	MTS	MTS2	Vest	PGA	LL	V–1	V–2	R2	n
Company C																
Tobit	-48.616	-37.942	-188.008	86.298	89.436	28.064	-30.474	46.679	-11.200	35.608	0.204	0.891	-1.803	-36.906		1196
Std. Err.	1.369	1.333	2.169	1.880	2.051	2.038	1.283	1.109	0.267	1.690	0.686	0.059	0.903	1.166		
OLS	-11.785	-10.014	-73.829	27.701	25.780	12.625	-13.354	19.838	-3.981	35.520	7.270	-0.487	-3.199	1.569	0.0546	1196
Std. Err.	8.586	8.892	14.093	12.875	13.667	14.003	8.528	6.572	1.483	12.208	4.583	3.997	6.204	6.208		
Rank	846507.838	-124.325	-216.376	168.412	80.352	19.675	-54.558	-70.983		123.081	-82.453	85.893	-54.059	-81.229	0.2158	1196
Std. Err.	54596.842	22.744	23.394	22.166	24.337	22.850	23.586	35.436		36.863	29.907	28.659	24.627	24.488		
Company D																
Tobit	-45.972	-6.475	17.008	-22.926	14.988	0.362	-2.412	29.141	-3.666	-84.202	8.898	2.400	-10.772	-15.491		4088
Std. Err.	0.180	0.175	0.213	0.270	0.232	0.254	0.159	0.114	0.018	0.919	0.157	0.012	0.112	0.117		
OLS	-9.808	-5.007	5.047	-2.067	9.145	6.388	-2.067	8.993	-1.003	-13.825	10.536	0.659	-1.516	-3.267	0.1056	4088
Std. Err.	2.035	2.038	2.415	3.037	2.719	2.851	1.856	1.306	0.206	8.750	1.813	0.141	1.234	1.299		
Rank	2284728.382	-4.104	23.381	-49.866	27.752	0.962	-10.963	238.161		1.715	15.256	214.715	-47.180	-71.974	0.1738	4088
Std. Err.	96883.821	12.670	12.507	13.241	12.702	12.506	12.627	14.386		20.513	15.240	15.462	13.178	12.761		
Company E																
Tobit	-111.653	-31.024	-25.042	8.866	84.922	29.198	14.548	45.043	-5.714	74.202	-16.703	2.080	15.477	15.969		946
Std. Err.	0.440	0.224	0.292	0.340	0.289	0.309	0.239	0.167	0.025	1.319	0.294	0.035	0.171	0.175		
OLS	-18.082	-5.728	-9.966	11.920	41.103	17.654	3.615	12.244	-1.516	65.633	-13.466	-0.331	12.055	3.932	0.111	946
Std. Err.	8.562	4.575	5.965	7.109	5.921	6.436	4.888	3.066	0.467	28.384	5.837	0.742	3.668	3.643		
Rank	193724.784	-127.301	-112.742	14.762	195.832	10.272	101.025	475.889		7.329	-50.099	176.770	2.597	61.611	0.2043	946
Std. Err.	58301.970	26.671	26.315	25.841	26.288	29.442	28.992	38.499		23.431	41.463	43.012	28.316	27.179		

	Intcp	R–3	R–2	R–1	R0	R1	R2	MTS	MTS2	Vest	PGA	LL	V–1	V–2	R2	n
Company F																
Tobit	-83.987	5.738	7.244	-9.868	36.485	-20.226	-2.664	38.787	-6.191	70.527	28.598	5.102	-15.293	-18.648		11755
Std. Err.	0.443	0.306	0.416	0.480	0.400	0.483	0.313	0.268	0.045	1.430	0.295	0.026	0.290	0.293		
OLS	-9.839	-0.904	1.202	-1.737	13.696	-5.557	1.035	13.241	-1.938	23.937	11.290	0.105	-4.965	-5.203	0.0505	11755
Std. Err.	1.368	1.071	1.474	1.689	1.404	1.703	1.102	0.918	0.152	4.747	1.073	0.072	0.953	0.946		
Rank	3127515.915	67.505	-30.311	-42.945	99.620	-80.955	14.023	55.814		485.426	31.803	213.290	-128.541	-137.536	0.3374	11755
Std. Err.	136980.760	6.419	6.257	6.042	6.037	6.082	6.497	7.293		11.897	6.292	10.272	7.943	8.107		
Company G																
Tobit	192.846	-16.072	136.520	58.224	-34.718	127.233	25.563	3.662	-3.018	65.686	-200.066	-50.085	-17.455	-31.746		3315
Std. Err.	0.310	1.020	2.731	2.394	2.782	2.475	1.028	0.274	0.059	0.264	0.180	0.037	0.709	0.684		
OLS	186.312	-13.130	28.397	-24.209	83.370	27.056	20.829	4.140	-2.757	78.468	-195.317	-47.163	3.196	-11.596	0.3429	3315
Std. Err.	10.900	35.520	92.045	80.330	93.543	80.730	35.419	9.592	2.072	9.197	6.365	1.308	23.166	22.917		
Rank	2923864.596	8.044	112.268	94.761	-142.936	138.335	64.918	-55.030		-48.948	-25.077	-533.447	-41.601	-60.960	0.4589	3315
Std. Err.	120815.875	15.094	29.789	25.498	30.406	25.289	14.315	18.800		20.140	18.102	24.050	26.737	26.617		
All Combined																
Tobit	-19.599	-9.841	-12.041	22.775	47.261	16.671	5.572	22.054	-3.315	-11.398	18.774	-0.415	-6.094	-13.342		25387
Std. Err.	0.035	0.051	0.075	0.081	0.075	0.079	0.054	0.027	0.005	0.084	0.023	0.002	0.034	0.033		
OLS	-9.320	-9.117	-16.646	22.613	44.004	13.172	5.064	16.930	-2.458	-5.526	11.050	-1.002	-0.549	-6.085	0.0875	25387
Std. Err.	1.015	1.472	2.106	2.290	2.126	2.240	1.535	0.775	0.132	2.474	0.665	0.055	0.927	0.917		
Rank	18836000.000	-26.278	-21.207	21.148	57.980	26.284	-1.662	107.325		-197.156	166.976	126.773	-76.012	-105.145	0.2752	25387
Std. Err.	158022.776	3.527	3.618	3.389	3.538	3.462	3.654	3.757		5.084	2.940	3.429	4.800	4.632		

Intcp	R–3	R–2	R–1	R0	R1	R2	MTS	MTS2	Vest	PGA	LL	V–1	V–2	R2	n

Notes: The unit of observation is a grant-month. Grant-months where the market-to-strike ratio is less than one are omitted. Regressions are estimated for all observations in the combined regression and then on a company-by-company basis. The first set of results for the combined and by-company regressions are for tobit regressions. The second set are parametric regressions. The third set are for rank regressions. Regressions are estimated applying weighted least squares with weights proportional to the square root of the inverse of the number of employees issued options. The dependent variable is percent of a grant exercised in a given month. *Intcp* is the intercept from the regression. *R-3* is the return over days –60 to –31, *R-2* is the return over days –30 to –16, and *R-1* is the return over days –15 to –1, all relative to the beginning of the month in question. *R0* and *R1* are the returns over the first and last half of the month in question, respectively, and *R2* is the return over days +1 to +15 relative to the end of the month. *MTS* and *MTS2* are the market-to-strike ratio and market-to-strike ratio squared for the grant at the end of the month. *Vest* is the fraction of the total grant that vests in the month. *PGA* is the percentage of the grant available to be exercised as of the beginning of the month, adjusted for the percentage of options which are not yet vested, those which have already been exercised, and those that have been cancelled. *LL* is the remaining option life to expiration in years. *V-1* and *V-2* are the standard deviation of daily stock price changes over one and two months prior to the month in question. *R2* is the adjusted R-squared from the regression and *n* is the number of observations over which the regression is estimated.

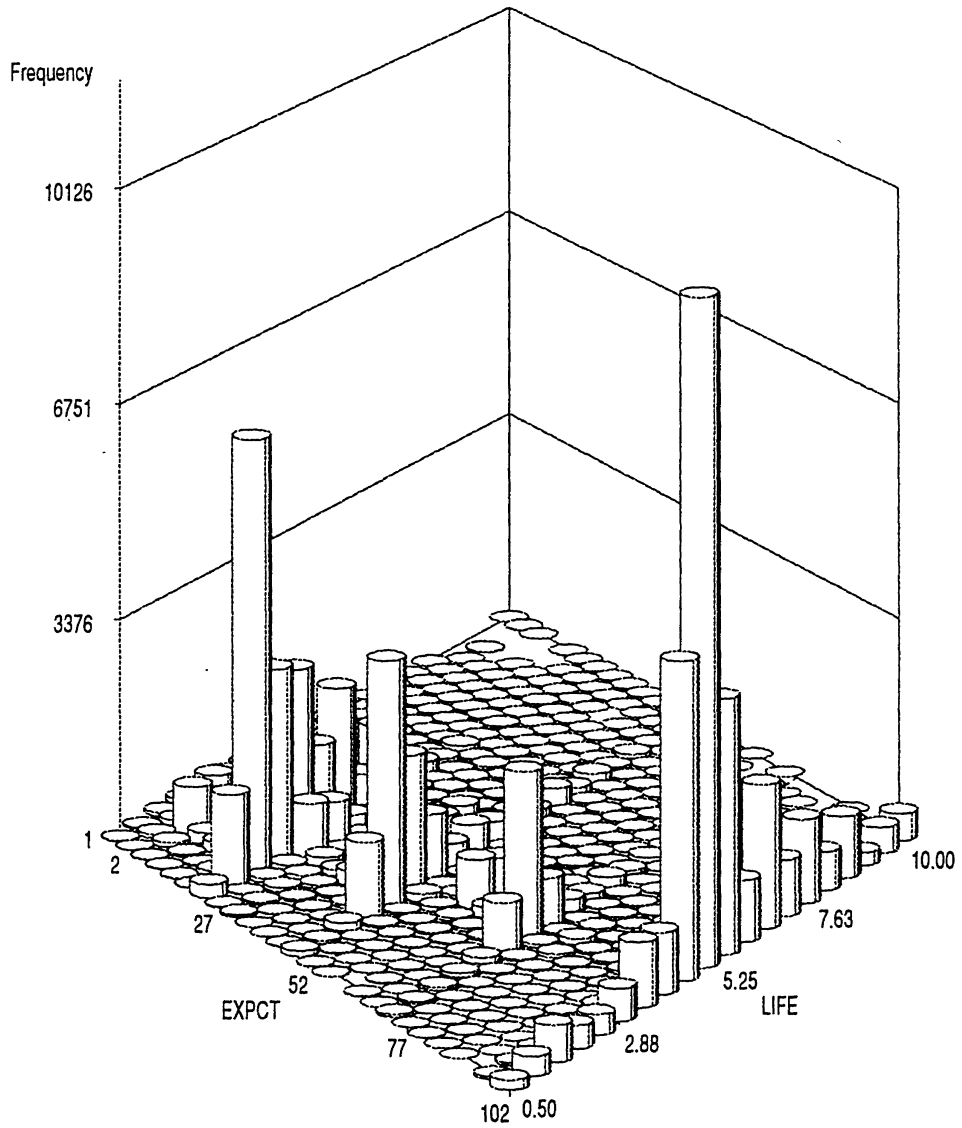
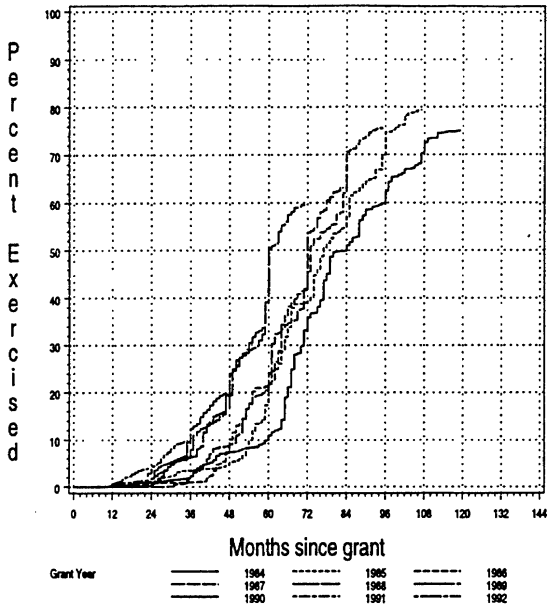
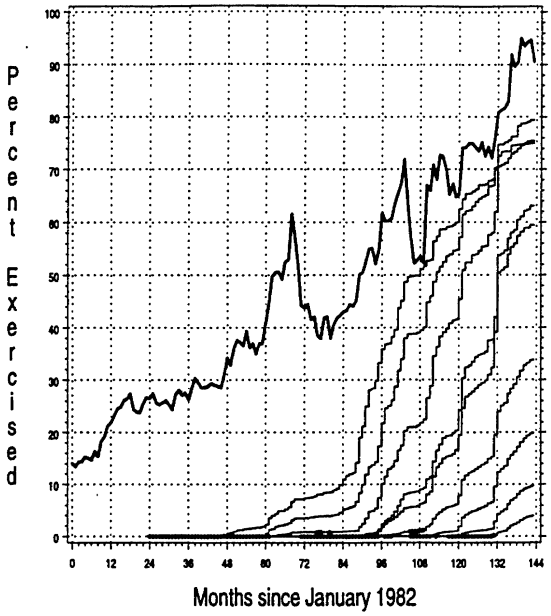


Figure 1

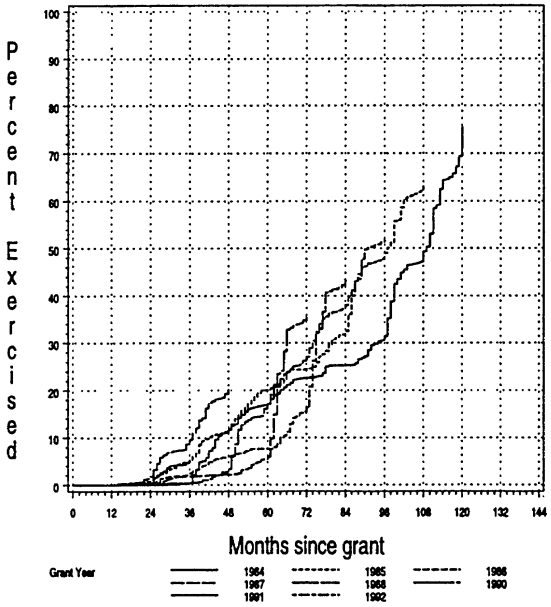
This figure plots the frequency of employee exercise decisions over the life of the option and the fraction of the grant exercised by the employee at one time. EXPCT is the percentage of shares granted to the employee that are exercised together. LIFE is the elapsed life of the option in years. There are 83,615 events in which employees exercise options in our data set. In the majority of cases, employees exercise at one time exactly 25%, 50%, 75%, or 100% of the options granted to them. Exercise of 25% of the grant is clustered at the first anniversary of the grant date. Similarly, exercises of 50%, 75%, and 100% of the grant are clustered at the second, third, and fourth anniversaries of the grant. This pattern suggests many employees exercise options soon after they vest.

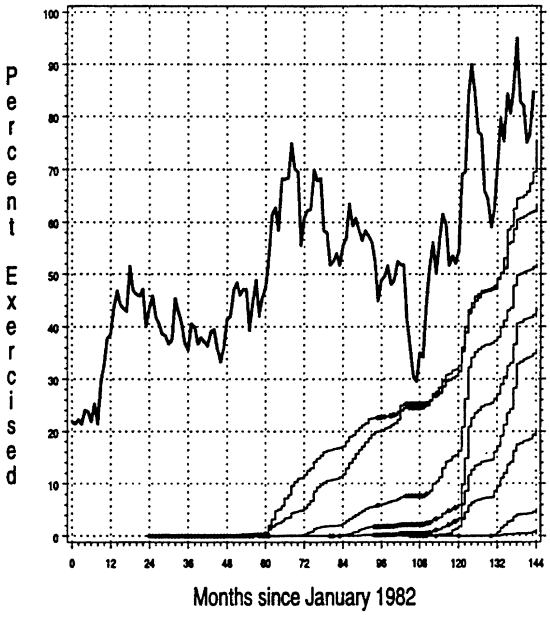
(A)


Percent Exercised
Months since grant
Grant Year
1984
1985
1986
1987
1988
1989
1990
1991
1992

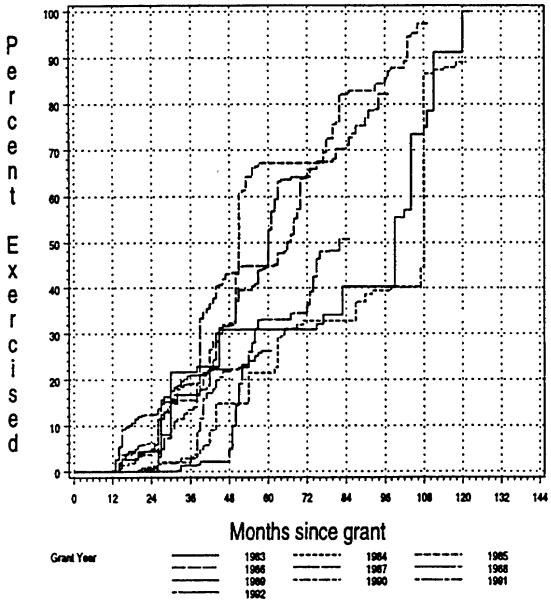

Percent Exercised
Months since January 1982

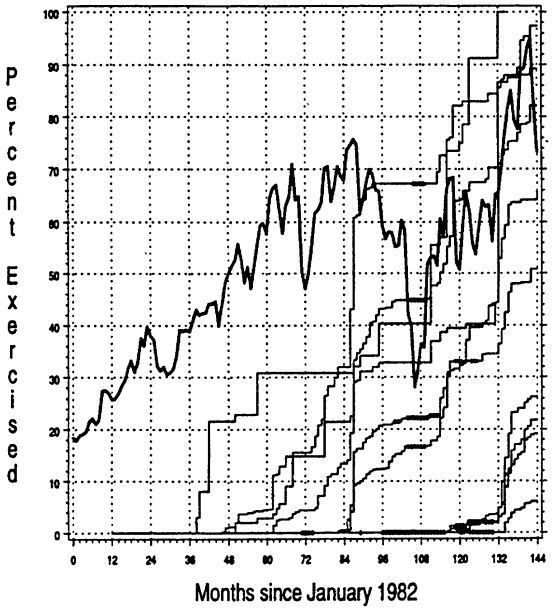
(B)


Percent Exercised
Months since grant
Grant Year
1984
1985
1986
1987
1988
1990
1991
1992

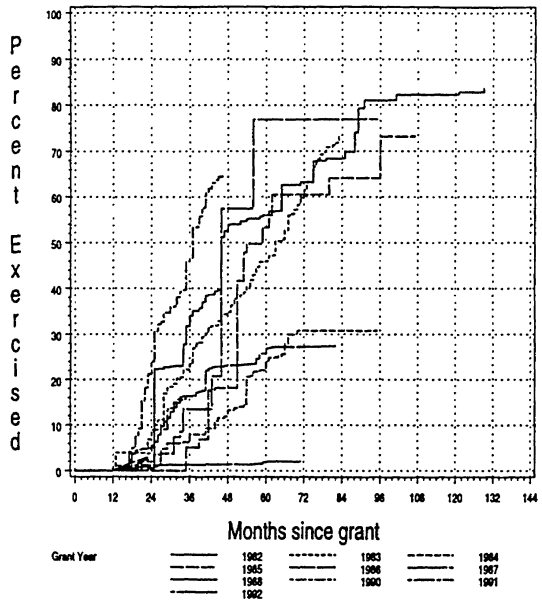

Percent Exercised
Months since January 1982

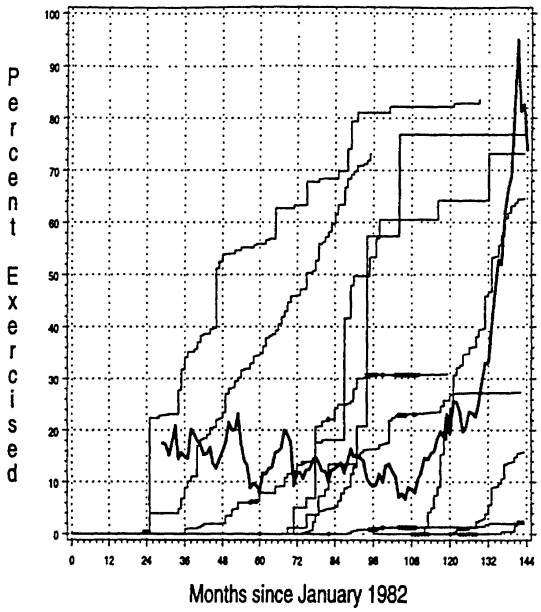
(C)


Percent Exercised
Months since grant
Grant Year
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992

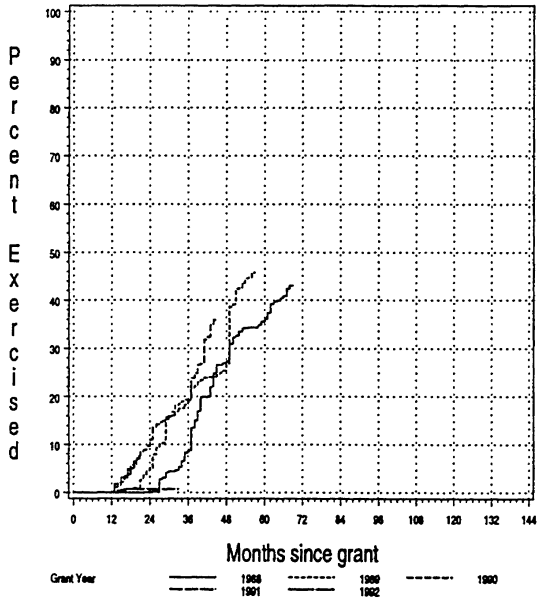

Percent Exercised
Months since January 1982

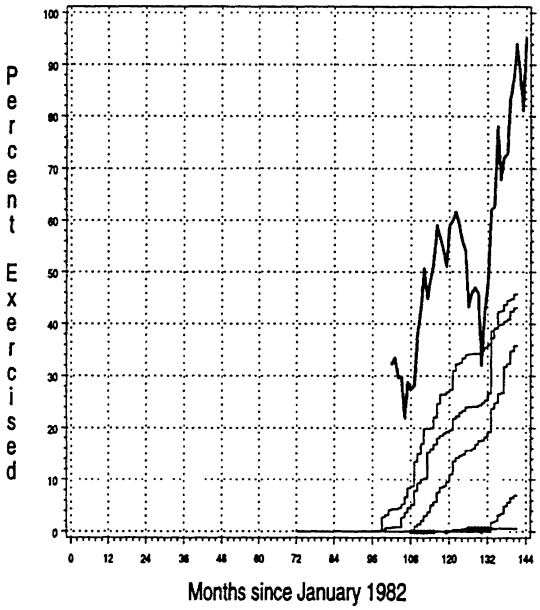
(D)


Percent Exercised
Months since grant
Grant Year
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992

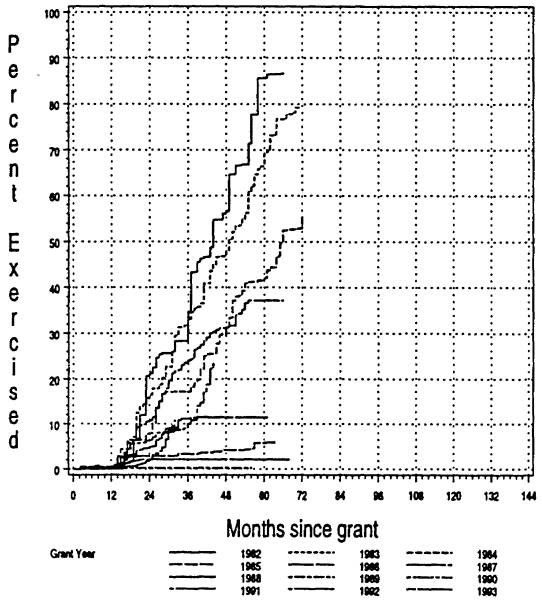

Percent Exercised
Months since January 1982

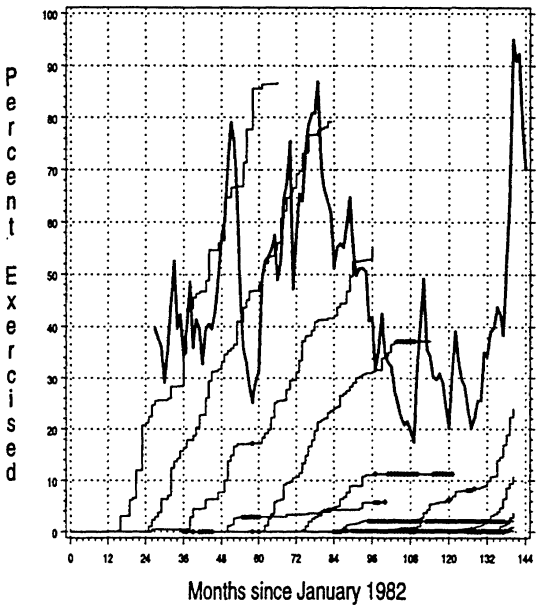
(E)


Percent Exercised
Months since grant
Grant Year
1988
1989
1990
1991
1992


Percent Exercised
Months since January 1982

(F)


Percent Exercised
Months since grant
Grant Year
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993


Percent Exercised
Months since January 1982

(G)

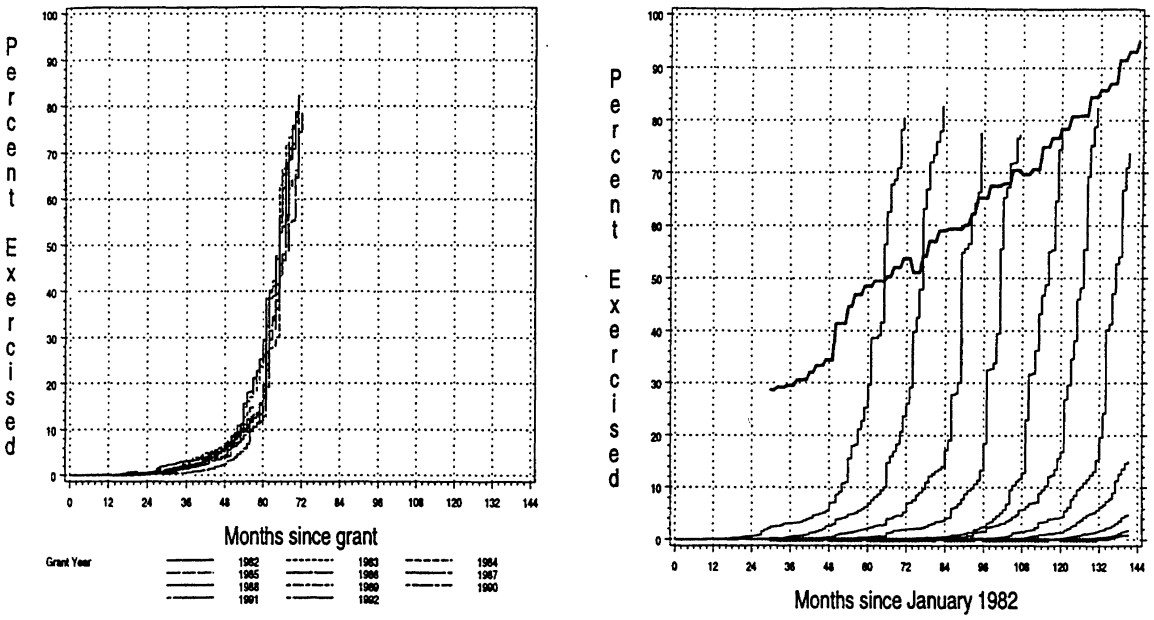


Figure 2 Companies A to G

Left-Hand Panels: Plot of cumulative options exercised since the grant date as a percentage of options granted. All options granted in one year are treated as a single grant. Data were computed by cumulating the options exercised each month by grant year and dividing by the total options granted. Right-hand Panels: Thin lines plot the cumulative options exercised as a percentage of options granted over calendar time. Gray circles overlaid on these lines indicate periods when the options were out of the money. All options granted in one year are treated as a single grant. Data were computed by cumulating the options exercised each month by grant year and dividing by the total options granted. The thick black line plots mid-month stock price.