Patterns of Stock Option Exercise in the United States[†]

by

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initial draft: September, 1997

this draft: November 24, 1997

[†] I am grateful to Jack Hughes for helpful advice.

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1. Introduction

Stock options granted by an employer corporation to its employees offer many benefits. They: (i) provide optionees with incentives to increase the stock price of the firm; (ii) serve as "golden handcuffs" that bind optionees to firms during the vesting period; (iii) allow optionees to recognize income at times that coincide with favorable tax treatment or personal liquidity needs; and (iv) may be treated as "off income statement compensation" by the employer for financial statement purposes. Of course options also have costs. They: (i) dilute existing shareholders' interests in the firm (but increase cash inflows to the firm); (ii) expose optionees to the risk of fluctuations in the employer's stock price; and, (iii) cause optionees to trade in their employers' stock and therefore put them at risk of violating insider trading rules.

Employee exercise behavior is essential to an understanding of both the benefits and costs of options. For instance, stock option grants often are intended to motivate employees to increase the employer's stock price. The beneficial incentives created by options depend on when and why employees exercise their options. In particular, the duration of the incentive differs if employees exercise options for cash immediately on the vest date rather than holding them until expiration, especially since many options have ten year lives but vest over four years. FAS 123 mandates disclosure of stock option compensation costs in corporate financial statements and the SEC requires that proxies state a value for the options granted to the five most highly compensated employees.[1] It is permissible to take exercise behavior into account in computing option costs for these external reporting purposes. Exercise behavior also should affect the computation of stock option costs that corporations undertake for internal decision-making, such as setting compensation level and mix. Furthermore, an understanding of employee exercise behavior potentially influences the choice of exercise restrictions such as vesting provisions.

This paper considers employee exercise behavior from three perspectives. In section 2, employee stock options (ESOs) are distinguished from traded stock options

[1] Many of these values are computed using the Black–Scholes formula, but FAS 123 and SEC regulation S-K §229.402 permits options to be valued using other option pricing models.

(TSOs) and certain valuation considerations peculiar to employee stock options are reviewed. Section 3 summarizes employee exercise behavior at a small sample of companies and relates this behavior to the valuation issues. Section 4 details the impact of taxation on employee exercise decisions and details some tax planning opportunities afforded by options. A brief conclusion ends the paper.

This paper is largely a synthesis of existing research. More detail on certain of the topics covered can by found in the references.

2. Valuation

This section presents an analytical framework for exploring the valuation consequences of the features that distinguish employee stock options (ESOs) from traded stock options (TSOs). The framework includes the Black-Scholes formula as a special case. Numerical examples convey the importance of these features to the valuation of ESOs.

2.1 Characteristics of Employee Stock Options

It is important to distinguish ESOs from TSOs. While the exercise of a TSO does not affect the welfare of holders of the underlying stock, the exercise of an ESO is dilutive since the corporation issues new stock to the optionee. Thus, ESOs are a type of warrant. While TSOs usually mature within one year of the date of issue, ESOs may be exercised in a window of time that extends over many years (see figure 1). ESOs, in common with TSOs, are usually "American" not "European" options (i.e., they can be exercised any time during the exercise window, not just at maturity).[2]

[Figure 1]

An important restriction on ESOs is that they cannot be sold by the employee to whom they are issued, and it is impractical for an employee to implement a trading strategy that would have the same effect as selling the option. Since ESOs cannot be

[2] After options vest, there are typically no restrictions on when they may be exercised, though corporate compensation committees may impose conditions on the exercise of ESOs, like attainment of specific accounting or performance targets, which do not apply to TSOs.

traded, the pricing and optimal exercise policies for TSOs, which rely on the absence of arbitrage opportunities between the option and a portfolio that duplicates the return of the option do not apply to ESOs. Since the employee cannot trade freely in either the option or the underlying stock, the value of the option to the employee, the optimal exercise policy, and the cost to the employer do not follow the classical arguments in the option pricing literature. Factors like risk aversion and liquidity needs in imperfect capital markets complicate exercise behavior and make valuation more difficult.

It is straightforward to illustrate the importance of exercise behavior on the valuation of ESOs. The expected cost of the dilution suffered by the existing shareholders caused by granting the option depends on the employee's exercise policy. Suppose the employee's policy is to exercise the option only at maturity. For simplicity, consider an American option granted at-the-money on a stock paying no dividends. Then the Black–Scholes value approximates the expected cost of the dilution. Now suppose the employee's policy is to exercise the option on the first occasion it is in the money. Then the expected cost is nearly zero. In practice, the exercise policy of employees, and the expected cost to shareholders, lie somewhere between these extremes.

Ideally, shareholders want to know whether the benefits of options, in terms of retaining and motivating employees, exceed the associated cost. This problem is exceedingly complex if the actions or trading strategies of the employees have an effect on the stock price, and strategies or actions differ depending on the employees' stake in the corporation. As a first step in attacking this challenging problem, assume stock price movements over time do not depend on employee actions. Where the employer grants stock options to low- and mid-level employees, it seems likely that the effect of any individual employee's action or exercise strategy on the stock price is negligible. Accordingly, the incentive effect of options for these employees should be small. Hence, the effect of granting options to low- and mid-level employees on the evolution of the stock price also should be small. Where the employer grants stock options to top executives, this assumption is less plausible. However, any increase in the cost of the option due to incentive effects is less than the concomitant expected increase in the value of the stock outstanding at the time the option is granted. Ignoring the incentive effect in valuing the option provides a benchmark cost of the option that can be compared to alternate forms of compensation.

2.2 Binomial model

The binomial model of Cox et al. (1979) is the workbench for the intuitions presented in this section. Figure 2 depicts changes in stock price over time as an ingrown tree. At every node of the tree, the stock price moves up with probability p or down with probability $1 - p$. On an uptick, the stock price increases by a factor of $s > 1$. On a downtick, the stock price falls by a factor of $1/s$. Thus, if the initial stock price is 1 and after i periods there have been k upticks (and $i - k$ downticks), the stock price in period i is s^j where $j = 2k - i$. Denote by (i, j) the node at time i in which the stock price is s^j. The number of steps in the tree, the probability of an uptick, and the factor by which the stock price increases on an uptick, can be chosen to approximate the distribution of future stock returns so that a probability can be assigned to each future stock price path. Option values may be computed as follows: Determine when exercise takes place along each path and compute the difference between the stock price on the exercise date and the strike price. The sum over every path of these discounted quantities, weighted by an appropriate probability, represents the expected present value of the option.

[Figure 2]

Any option valuation process must begin by specifying some parameters. The expiration date, vesting schedule, strike price and current stock price are readily determinable. Future interest rates, dividend yields, and stock volatilities are more difficult to determine. Likely, the most difficult estimates concern employee exercise behavior. Reasons for exercise before expiration include employee risk aversion and liquidity needs; separation from the employer; and, dividend capture. The last of these has been thoroughly examined in the finance literature. Each of the other issues has been analyzed in a binomial framework (see, e.g., Carpenter, 1994; Cuny and Jorion, 1995; and Huddart, 1994). To illustrate the general approach, I describe the impact of risk aversion in some detail.

Since an employee's total personal wealth (e.g., options, stock, salary, and human capital) typically is concentrated in assets that are highly correlated with the employer's

stock price, we may expect employees to exercise options in order to hold better diversified, less risky portfolios. The example below illustrates how the optimal option exercise policy depends on the risk aversion of the employee and how exercise before expiration may be optimal.

EXAMPLE. Consider the tree in figure 2. At time zero, the employer grants the employee an option to buy stock at a strike price of $X = 1$ at either time 1, time 2, or time 3. Suppose the probability of an uptick is $p = 2/3$ at every node. Following an uptick the stock price doubles (i.e., $s = 2$). After a downtick, the stock price falls by half. The expected return from holding the stock is equal to the expected return from holding the riskless asset, $ps + (1-p)/s = d$, so $d = 1.5$. To keep the analysis simple, assume no taxes are imposed on the optionee.

Suppose the employee evaluates exercise strategies according to the distribution of her wealth at the maturity of the option. If she exercises the option at node $(2,2)$, she receives $(s^2 - 1)$ to be invested for one period at rate d. If she waits, she receives $(s^3 - 1)$ with a probability of p and $(s-1)$ with a probability of $1-p$. The employee will wait to exercise if she prefers the gamble of waiting to the payoff from exercising now. This relationship holds more generally. The employee will exercise the option at $(1,1)$ if and only if $EU\big(d^2(s-1)\big) > pEU\big[B(2,2)\big] + (1-p)EU\big[B(2,0)\big]$ where $EU(\cdot)$ denotes expected utility for terminal wealth and $B(i,j)$ is the stochastic payment realized by the employee from carrying out the optimal strategy at (i,j).

A risk neutral employee only exercises the option at nodes $(3,3)$ and $(3,1)$. When the employee has square root utility, she strictly prefers to exercise the option at $(2,2)$ to waiting until either $(3,3)$ or $(3,1)$ obtains. When the employee is more risk averse, she finds it optimal to exercise the option at $(1,1)$ as well. Early exercise means paying the exercise price early. Acceleration of this payment reduces the risk of the final payoff by allowing the employee to switch from an investment in the risky option to a less risky asset, at the cost of lowering the expected return.

2.3 Optimal Exercise Policy

The optimal exercise policy for an ESO can be found from a recursive algorithm. The algorithm is a straightforward extension of the machinery used in the example. Figure 3 presents the optimal exercise policy in a specific case (using plausible parameter values) and gives the intuition for the regions of (time, stock price) space where exercise is optimal. The plot assumes the option vests two years after the date of grant. The set of nodes at which the employee chooses to exercise grows larger as the employee becomes more risk averse.

[Figure 3]

A risk neutral employee never exercises the option early because the expected payoff from holding the option to maturity always exceeds the expected payoff from early exercise. Besides the expected payoff, a risk-averse employee also cares about the shape of the payoff distribution. The payoffs from exercising the option now or at maturity differ in this regard. The possible payoffs from holding the option to maturity resemble a standard lognormal distribution shifted left (by payment of the exercise price) and truncated at zero. The probability mass from the truncated section of the distribution is assigned to the zero payoff. Since there is a significant chance the option will expire out-of-the-money, holding the option entails a large probability of a zero payoff. Exercising the option early to hold the stock offers a lower expected return, but there is no chance of a zero payoff. If the employee evaluates the payoff distribution from exercising the option now as sufficiently less risky than holding the option until the next period, she will exercise now. The reduction in risk compensates her for the lower expected payoff.

Suppose the employer grants the employee an option to buy 10,000 shares of the firm's stock that vest after two years and expire at the end of five years. Suppose further the initial stock price and the strike price are both \$20. Consistent with the parameters underlying Figure 3, the stock price evolves according to a lognormal process with a mean of $\mu = 10\%$ and a volatility of $\sigma = .3$ per year. The employee's objective is to maximize her expected utility after five years. Assume the employee exhibits preferences described by the utility function $U[W] = W^{\gamma}$ where $\gamma = {}^{1}\!/_{4}$. For simplicity, the employee

has no wealth other than the option and may invest the proceeds from exercising the option in a riskless asset that offers the same expected return as the stock.

With these parameters, the employee is indifferent, at the date of grant, between the option and a sure payment today that gives the same utility. The sure payment today that makes the employee indifferent is $36,960. If instead of an option that vests after 2 years, the employee receives a European option, she foregoes the opportunity to exercise early. Imposing this restriction, the corresponding sure payment today is $30,881. Thus, the value the employee places on the American option is about 20% more than the value she places on the European option.

A risk-averse employee chooses an exercise policy that maximizes her expected utility. This policy does not, in general, coincide with the policy that maximizes the expected value of the option. Therefore, the expected cost to the employer of granting the ESO, given the employee's optimal exercise policy is less than the expected cost of an option, given an exercise policy that maximizes expected value. Option pricing models for tradable options effectively assume the exercise policy maximizes expected value. Thus, the expected cost to an employer who issues an ESO is less than the naive use of options pricing models would suggest.

To determine the cost incurred by shareholders at the date of grant of an employee stock option, one ideally would like to have a competitive market for such claims in which third parties quote a price at which they will assume the obligation to honor the call option. This market, if it existed, would clear at a price that satisfies the FASB's concept of "fair value." The price the employer would pay to defease the obligation is the cost of the option to the employer.

For every employee exercise policy, there exists a portfolio of the firm's stock and a riskless asset, called the hedging portfolio, that exactly mimics the payoff from the employee stock option. Provided the third party carries out the trading strategy that replicates the option's payoff, the third party bears no risk. This is because closing out the riskless asset and stock positions yields an amount that, added to the exercise price, equals the funds the employee requires to purchase the underlying stock. Competition among third parties will drive the cost of defeasing the option down to the cost of the hedging portfolio at the grant date.

This cost can also be estimated recursively from the binomial tree. Continuing the example above, the cost at the date of grant to defease a European option is $108,879. This is also the Black-Scholes value of the option. The cost to defease an American option, assuming the employee adopts the exercise strategy that maximizes her utility, is $94,317, about 13 percent less than a European option. Thus American options are less costly to the employer and more valuable to the employee than European options. Lengthening the vesting period reduces the set of circumstances under which the employee exercises the option before maturity. Thus, postponing the vesting date lowers the value of the option to the employee and increases the cost of the option to the employer, and may increase the duration of desirable incentive effects. The increased cost to the employer may be offset by these effects.

These relationships hold more generally. Risk aversion induces early exercise when either (i) the option is near-the-money, the time to maturity is very short, and substantially all the employee's wealth is in options; or (ii) the option is deep-in-the-money and less risky investments are available. As the set of circumstances under which the employee exercises the option (i.e., the exercise region) grows larger, the cost of the option to the employer decreases. The exercise region is jointly decided by the employer, who sets the vesting schedule, and the employee, who decides whether to exercise when exercise is allowed. The cost to an employer who issues an ESO is less than standard option pricing models for traded stock options would suggest.

This section has illustrated how employee stock options may be valued taking account of risk aversion of the part of employees. Other reasons for exercise, such as liquidity needs or employee turnover, may similarly be modeled by specifying at each node the probability of exercise attributable to these factors.

3. Evidence on exercise decisions

As the previous section illustrated, there are many reasons why exercise of ESOs may differ from the exercise of TSOs. Direct evidence on exercise behavior serves to establish the economic significance of these factors to option valuation. Huddart and Lang (1996) analyze patterns in exercise behavior from the detailed grant and exercise records of eight corporations over a decade. Together, these corporations issued options to almost 60,000 employees during the last decade. The sample includes a range of firms—one large industrial company, one large high-technology company, two financial services companies, three small high-technology companies that undertook initial public offerings, and an employee-owned service company. All options in the sample are fixed stock options with strike prices equal to the market price on the date of the grant. These data permit the description of the general nature of grant and exercise activity and the factors associated with exercise.

The companies supplying data requested anonymity. Accordingly, they are identified by a letter code only. For brevity, I sometimes focus on the results for two companies that span many interesting patterns in the data, Companies B and H. Company B issued ten-year options that vest ratably at 25% per year. Company H issued only five-year options that vest annually in increments of 10% to 40% over four years. Data on the employees granted options show option grants extended deep into the organization. Options were granted to 24,126 employees in Company B and 13,146 in Company H at some time during the sample period.

3.1 Univariate Analysis of Exercise Activity

Table 1 presents summary statistics on exercise activity aggregated over all employees at the eight companies in the sample. Line 1 presents the fraction of options issued to an employee in one grant that are exercised together. The median value is .50, which suggests employees generally exercise options from one grant in a few large transactions. Line 2 describes the distribution of the fraction of the life elapsed at exercise. This figure is biased downward because the data include partial histories of many option grants. Line 3 corrects for this by presenting the fraction of life elapsed at exercise for options

for which more than 85 percent of the options' history is included in the data. The median value over all employees at the eight companies is .82. The median values over employees at a single company range from .41 to .96. These figures indicate that much exercise takes place well before expiration of the option, and moreover, that there is variation across companies in the propensity to exercise early. Line 4 presents the ratio of the proceeds from exercise (market minus strike price) to the Black-Scholes value of the option computed at the exercise date. The median value for this variable ranges from 0.55 to 0.99 over the companies in the sample. A low value suggests employees sacrifice a large portion of the option's expected value if held to expiration. Similarly, line 5 presents the ratio of the proceeds from exercise to the Barone-Adesi and Whaley (1987) value of the options computed at the exercise date. The Barone-Adesi and Whaley computation lowers the options' values to adjust for dividends, while the Black–Scholes formula does not. Thus, the ratios on line 5 are lower than those in line 4, but also suggest substantial sacrifice of value from early exercise. The value sacrificed is greatest in the large public companies. The value sacrificed in company H is negligible. This is because employees at company H tend to hold options until maturity. The value sacrificed is also low for start-up companies that issued options with very low strike prices to employees before going public. Because the strike price on these options is a small fraction of the post-IPO market price, the intrinsic value of an option any time after the IPO nearly equals the option's Black–Scholes value, so value sacrificed is low.

[**Table 1**]

3.2 Exercise and vesting

Additional evidence on exercise patterns is available in figure 4. The unit of observation in the figure is an individual employee's decision to exercise one or more options from a given grant. There are 85,853 exercise events. The frequency of these events is plotted along two axes. One axis records the time of exercise, measured from the date of grant. This axis is divided into six month intervals. The second axis records the percentage of options issued to an employee in one grant that are exercised together. This axis is divided into intervals that represent ranges of 5 percent. Consistent with table 1, the

distribution across exercise percentages suggests employees typically exercise options in large blocks. By far the most common block sizes are 25%, 50%, 75% and 100% of options granted. Looking over the life of the option, the mode 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 second half of the fifth year of option life. The peak at the beginning of the second year of option life and 25% of options granted suggests that many employees exercise the maximum permissible number of options shortly after the first vesting anniversary. The other peaks suggest some employees wait past this anniversary, but then exercise all available options soon after a subsequent vesting date. Further, the graph confirms that much exercise takes place well before expiration.

[Figure 4]

3.3 Exercise over time

Figure 5 offers a different perspective on the data prompted by the possibility that exercise activity may cluster in time since grant or calendar time. The left panels of figure 5 present cumulative monthly exercise as a percentage of options granted for Companies B and H. In these panels, time is measured in months since the grant date. Each line corresponds to the options granted in a single calendar year.[3] Dispersion across grant-years for Company B indicates exercise patterns vary greatly. Exercise activity a given number of months after the grant date does not seem highly correlated from grant to grant.

[Figure 5]

The right-hand panels of figure 5 contain the same cumulative exercise lines as in the left-hand panels, but the lines are aligned in calendar time instead of time since the grant date. For each company, the mid-month stock price also is plotted in the

[3] Where a company made more than one grant in a year, the amount granted is the sum of the grants made in the year, and the amount exercised in a month is the sum of the amounts exercised from each of these grants.

right-hand panel. If the option is out-of-the-money in a given month, then a black dot is overlaid on the cumulative exercise curve. It is apparent from the right-hand panel for Company B that exercise clusters across grants in certain months. Further, those months appear to coincide with periods of substantial price appreciation. Thus, stock price movements appear to be important determinants of exercise for in-the-money options. This observation stands in sharp contrast to what we would expect to see for TSOs, since exercise before expiration is generally sub-optimal and not a function of either recent share price movements or time.

Company H stands in sharp contrast to Company B. Most employees at Company H wait until just before expiration to exercise the options they hold. Relative to Company B, at Company H there is high correlation across grants in cumulative exercise measured from the grant date. Also, exercise at Company H on average occurs much closer to the expiration date of the stock option than at any other company. It is apparent from the figure that Company H's stock price is much less volatile and more predictable than the stock price of any other sample company. In fact, Company H's stock price is an internally generated function of financial accounting earnings and book value.[4] Because the stock price process is more stable, the probability distribution representing the beliefs of an employee at Company H about his options' intrinsic value at any future time likely is more concentrated than the probability distributions in the minds of employees at Company B. Thus, options on the stock of Company H are much less risky. The finding that exercise occurs much later at Company H is consistent with the predicted interaction of risk aversion and volatility: employees are willing to hold less risky options longer.

Regression analysis offers further insights. Huddart and Lang (1996) regress the fraction of options from a given grant exercised in a month on characteristics of the option in that month pooled across grants, firms, and time. The results for the seven public companies confirm recent returns are positively associated with exercise.[5] Regression

[4] Company H makes a market in its own stock. Employees are free to sell shares acquired on exercise of options in this market. The market-maker ensures demand equals supply at the formula price through discretionary mechanisms such as stock purchases for the company ESOP.

[5] Company H is excluded because it is a privately-held company. Its "stock price" for purposes of determining option value is set internally every ninety days and is therefore not comparable to the market-determined prices for the public companies.

coefficients on contemporaneous and lagged returns strongly suggest exercise behavior occurs in response to recent stock price movements. The relation is positive for contemporaneous and lagged returns up to twelve weeks before the exercise event. The relation is negative for the longer lagged returns, which suggests exercise activity is path dependent: exercise occurs in periods in which the stock price is rebounding from a previous fall. The results also confirm that greater exercise is associated with higher stock price volatility.

3.4 Exercise by employee level

If factors like risk aversion and liquidity needs influence exercise behavior, exercise is likely to vary based on the personal circumstances of the employee. While data on employee-specific characteristics is unavailable, it is possible to infer something about those characteristics from an employee's level in the company. In particular, the amount and allocation across asset classes of high-level employees' wealth is likely to differ systematically from lower-level employees. Also, the risk attitudes of employees may differ systematically by level. Finally, the visibility of high-level employees may limit their willingness to exercise options early for perceived loyalty issues.

[**Table 2**]

Table 2 describes employee exercise activity in proximity to vesting dates, broken down by level of employee within the organization. Employee levels are computed according to the total number of options granted to the employee over the sample. The table shows that 64.1% of exercise events for the lowest level of employees occur in the six months following an option vesting date. This is nearly twice the rate for high level employees. Moreover, the fraction of exercise events that follow closely on a vesting anniversary increases monotonically across employee levels for all windows following vesting dates. The results suggest vesting schedules are less significant to the exercise decisions of high level employees than to low level employees.

Regression analysis by level further supports the following observations:

- On the whole, behavior is consistent across levels. Explanatory power is lower for the highest level employees, but otherwise quite comparable.

- The most pronounced differences are for historical stock price variance. The coefficient estimate on historical price variance is insignificantly negative for the highest level of employees and increases monotonically across levels. The coefficient estimate is quite significant for lower levels, consistent with greater risk aversion for lower-level employees.

- Recent vesting has little effect on the exercise behavior of the highest level of employees, but has significant explanatory power for lower-lever employees.

- Similarly, the coefficients on the returns variables are lowest for the high-level employees, suggesting they are less sensitive to recent stock returns.

- High-level employees are more sensitive to stock price levels than lower-level employees.

This section offers several insights. First, it appears early exercise is a pervasive phenomenon, but varies from company to company and grant to grant. Exercise is strongly positively related to volatility. Recent stock price movements and vesting dates also contribute significantly to explaining exercise. Since the results are generally similar across sample companies, employee exercise behavior seems consistent over the range of factors represented in the data. Analysis by level of employee points to differences across employees. The results are broadly consistent with predictions of the effect of risk aversion on option exercise.

For compensation design more generally, the data imply an analysis of the incentive features of options should anticipate the pervasiveness of early exercise. For example, a ten-year option may serve to align incentives for only five years if exercise typically takes place then. Further, the duration of incentive effects depends on stock price performance.

4. Taxation

Taxation is a key factor in setting option compensation and realizing maximal value from that compensation. Exercise at opportune times may enhance the net-of-tax value of options to employees or reduce net-of-tax costs to the employer. This section summarizes employer and employee preferences for exercise before a tax rate change for all possible changes in employee and employer tax rates. It presents as a case study the exercise decisions of top executives at a major corporation before the 1993 personal tax rate hike. Then a broader investigation of tax-motivated exercise is summarized. Finally, a framework for analyzing the attractiveness of exercising non-qualified options to benefit from lower capital gains tax rates is presented.

Variation in taxation across countries may be expected to result in different option granting and exercise practices. Table 3 illustrates the variety of tax treatments accorded employee stock options across national jurisdictions. Scholes and Wolfson (1992) explain how the net-of-tax efficiency of incentive stock options compared with non-qualified options in the United States depends upon tax rates. If the corporate tax rate exceeds the personal tax rate on ordinary income then non-qualified options dominate incentive stock options. When the personal tax rate exceeds the corporate tax rate and the capital gains rate is low, then ISOs may dominate NQOs. This kind of analysis suggests differences in tax treatment may explain variation in the use of stock options across national borders. For instance, Canada allows no deduction to employers for options exercised by employees although there is an income inclusion for the employee. Consequently, options should be used less frequently in Canada than in the U.S. Mawani (1991) cites some evidence consistent with this observation.[6]

[6] Financial reporting considerations also appear to influence stock option usage. Matsunaga (1995) finds use of income increasing accounting methods, such as FIFO, is associated with larger stock option grants. Moreover, tandem grants of stock appreciation rights, which would reduce reported income, and options are less likely in firms that use income increasing accounting methods. Also, earnings are below a target level are associated with larger stock option grants.

Other evidence on stock option plan designs is more puzzling. Egginton et al. (1991) point out that in the United Kingdom, amounts paid to repurchase stock delivered to employees who exercise stock options are a tax deductible expense for the employer corporation, but new shares issued to employees who exercise stock options do not produce a corporate tax deduction. Furthermore, the Companies Act mandates more disclosure of option grants made under plans where exercise of options results in new stock being issued to employees than grants under plans where repurchased stock is delivered to employees. While one might expect that low disclosure and tax benefits combine to make repurchased stock plans the common choice in the UK, just the opposite is true in Egginton et al.'s sample.

Jennergren (1997), who considers the taxation of options in Sweden from the perspective of the tax collector, shows that alternate tax rules are not revenue neutral.

[Table 3]

Taxation reduces proceeds from exercise. Tax planning opportunities arise if tax rates vary over time or types of income, or if rules governing the deductibility of option compensation to the employer and the timing of the employee's inclusion change. For U.S. non-qualified options, the difference between the stock price on the exercise date and the option's strike price is taxed at ordinary rates in the year of exercise. Subsequent appreciation of stock acquired by exercise of options is taxed at capital gains rates when the stock is sold. In the last fifteen years, top federal personal tax rates have ranged between 28 percent and 50 percent. Since employee stock options often have terms of ten years, changes in tax rates potentially have an effect on the employee's exercise policy, and hence an indirect effect on the cost of the option to the employer. Non-qualified options also affect the employer's compensation cost directly since the difference between market value on the date of grant and the exercise price is a deductible expense for tax purposes.

4.1 Effects of tax on exercise—simple case

To illustrate the effects of tax on the exercise decision, consider a United States employee who holds a non-qualified option. Assume the employee seeks to maximize expected terminal portfolio value. Further, assume (i) the employee's exercise decision is unaffected by interim liquidity needs, (ii) the employee has no private information about stock value, and (iii) the stock pays no dividends.[7] Employee and employer marginal tax rates were about to change from t_1 and T_1 to t_2 and T_2, respectively. Let S_1 be the current stock price; X, the strike; and W_1^e, the pretax value the employee would accept today in exchange for surrendering the option. The employee favors exercise immediately before the tax rate change when the net-of-tax payment from exercise now exceeds the net-of-tax payoff from exercise after the tax rate increase, i.e.,

$$(S_1 - X)(1 - t_1) - W_1^e(1 - t_2) \tag{1}$$

[7] Conceptually, early exercise of an employee stock option to benefit from a low tax rate resembles early exercise of a traded stock option to capture a dividend. Because traded stock options have shorter lives, they are less likely to be as far in-the-money as employee stock options. Thus dividend capture is generally worthwhile only at the last dividend ex-date preceding option expiration, while tax factors may precipitate exercise of options that are years from expiration.

is positive, or

$$\frac{S_1 - X}{W_1^e} > \frac{1 - t_2}{1 - t_1}. \tag{2}$$

Intuitively, if the employee exercises a deep-in-the-money short maturity option before the tax rate increase, she captures a large fraction of the option's expected total value and benefits from having this value taxed at a low rate. See figure 6.

[Figure 6]

Employees must also consider the likelihood that future tax rates will differ from current tax rates. If tax rates are unlikely to increase, then the attractiveness of early exercise is reduced commensurately. If tax rates were to rise only temporarily, so that the option expires after the temporary tax rate hike reverses, then there is no tax benefit to early exercise because the employee could postpone exercise until after the reversal.

4.2 Case study

Following the election of President Clinton on November 3, 1992, there was widespread expectation that personal income tax rates for high levels of income would increase in 1993. Option exercises by insiders putatively motivated by tax factors was widely reported in the business press.

There was little uncertainty whether tax rates would increase, but there was considerable uncertainty over the income level at which tax higher tax rates would apply and whether the increase would be effective January 1, 1993. In fact, tax rates did rise effective January 1, 1993. Moreover, the tax rate rise affected more people than 1992 press reports suggested because the 36 percent bracket applied to taxable income over $115,000, and the 39.6 percent bracket (which embodied the Clinton proposal of a 10 percent surtax on millionaires) applied to taxable income over $250,000 for individuals filing jointly.

The importance of tax considerations is illustrated by the actions of Michael D. Eisner and Frank Wells, respectively Chairman and late President of Disney. In the last quarter of 1992, when Disney stock trading at $40 per share, these executives exercised 6,640,000 options expiring in 1994 with a strike of $3.59 per share. Salary and bonus

levels for Eisner and Wells show they are in the top California and federal tax brackets. If Eisner and Wells believed the top federal rate would rise from 31 percent to 36 percent in 1993, a 10 percent federal surtax would be applied in 1993, and California state income tax would remain at 11 percent for 1993, then they expected to receive after tax $(1 - 11\%)(1 - 31\%) = 61.4\%$ of an incremental dollar of income reported in 1992; and, $(1 - 11\%)\big(1 - 36\%(1 + 10\%)\big) = 53.8\%$ of an incremental dollar of income reported in 1993 or later. That is, for every dollar of income triggered in 1992, 61.4¢ is left after tax, while for every dollar of income triggered in 1993 or later, only 53.8¢ (or 12 percent *less*) is left after tax. This makes the early exercise of options held by Eisner and Wells attractive from their perspective. An estimate of the tax avoided by accelerating exercise is $(61.4\% - 53.8\%) \times (\$40.00 - \$3.59) \times 6,640,000$ or $18 million. This benefit is offset by (i) the acceleration of tax and strike price payments and (ii) the diminished opportunity to participate in future appreciation of the stock. The net benefit is greatest when the option is deep-in-the-money and the time to maturity is short.

Significantly, Eisner and Wells also held, but did not exercise, options expiring in 1999 with strike prices of $17.14 and $19.64.[8] Let the Black–Scholes value of the option proxy for the pretax present value of the expected payoff from the option if held to maturity. Then $(S_1 - X)/W_1^e$ is .9951, .8070, and .7607, for the options with strike prices of $3.59, $17.14, and $19.64, respectively.[9] The option income of these executives would be taxed at an estimated rate of 38.6 percent in 1992 or 46.2 percent in 1993. Thus, $(1 - t_1)/(1 - t_2) = .8754$. These calculations and relationship (2) suggest tax factors can explain the decisions by Eisner and Wells to exercise the $3.59 options, and to not exercise the $17.14 and $19.64 options.

[8] See David J. Jefferson, "Disney Officials Get $187 Million From Stock Sale," *Wall Street Journal* (December 2, 1992) p. A3.

[9] The Black–Scholes value is estimated using a short Treasury note yield of 5.03 percent and estimated volatility for Disney stock of 27 percent per year.

4.3 Employer preferences

From Disney's perspective in late 1992, early exercise preserves a deduction for compensation expense that might otherwise be lost because of a legislative proposal to deny a deduction for compensation above $1 million paid to any one person. Thus, Disney would favor early exercise to assure itself of the deduction, worth about 34 percent of the difference between the market value of the stock and the exercise price or $82.2 million.[10]

More generally, the employer's preferences with respect to the optimal time to exercise the option do not, in general, coincide with those of the employee. The employer may find it worthwhile to induce the employee to exercise (or not exercise) before rates change. If it were up to the employer to decide when to exercise the option, he would compare the after-tax cost of compensation paid to the employee under early exercise, $(S_1 - X)(1 - T_1)$, with the expected after-tax cost of compensation to be paid to the employee when exercise is postponed until after the tax rate change, $W_1^r(1 - T_2)$, where W_1^r is the pretax present value of the expected cost the option. Thus, the employer favors early exercise if

$$\frac{S_1 - X}{W_1^r} < \frac{1 - T_2}{1 - T_1}. \tag{3}$$

The employee and employer both favor early exercise when (2) and (3) both hold. It is also possible the employer may favor early exercise while the employee favors exercise at maturity. The employer could induce the employee to exercise early (or surrender the option if it is out-of-the-money) by offering to pay the employee an amount, F, contingent on early exercise. For this proposal to be acceptable to the employee, F has to satisfy

$$\big(\max(S_1 - X, 0) + F\big)(1 - t_1) \geq W_1^e(1 - t_2).$$

The employer finds paying F worthwhile if

$$\big(\max(S_1 - X, 0) + F\big)(1 - T_1) < W_1^r(1 - T_2).$$

[10] As enacted, §162(m) of the Internal Revenue Code does not apply to most stock option compensation.

There are two other possibilities: both the employer and employee favor exercise at maturity, and the employee favors early exercise but the employer does not. Table 4 summarizes all possibilities. In a situation that closely corresponds to situation 2 in the table, Matsunaga et al. (1992) provide anecdotal and empirical evidence on the prevalence of payments to compensate employees engaging in a disqualifying disposition of incentive stock options. The next section considers a specific instance of situation 1.

[**Table 4**]

4.4 Empirical examination of the 1993 tax rate increase

Are tax considerations widely appreciated by optionees? Figure 7 summarizes Huddart's (1997) examination of the exercise behavior of a subset of more than 30,000 of the employees studied in Huddart and Lang (1996) for whom some 1993 salaries were also available. Employees' option positions following the election of Clinton in 1992 were tabulated according their intrinsic ratio, the fraction of the options' total pretax value that would be realized on exercise (i.e., $(S-X)/W_1^e$ using the notation developed above). Options with higher intrinsic ratios are more likely to be exercised before the anticipated tax rate increase. Option positions were further subdivided by the salary level of the employee, to test the hypothesis that employees with higher salary could expect to face higher rates of tax in 1993 and therefore be more likely to exercise options late in 1992.

[**Figure 7**]

To control for the other factors affecting exercise, the fraction of options exercised for each salary category and intrinsic ratio level for the same periods in 1990, 1991, and 1993 were also calculated. The differences between the fraction exercised in 1992 and the other years are reported in Figure 7. Set against an overall likelihood of exercise of less than 3 percent, there is a tenfold increase in exercise of options with high intrinsic ratios held by high salary individuals in 1992. Consistent with the tax hypothesis, the frequency of exercise attenuates as both the intrinsic ratio and the employee's salary decreases.

While this evidence suggests some employees do respond to tax factors, it also suggests that many employees who stand to benefit from early exercise to avoid higher expected tax payments do not do so. Two-thirds of the employees with highest incomes holding the options with the highest intrinsic value did not exercise. Because the trade-off is complex, it is possible that some employees were unaware of the benefits to be realized. Compensation consultants may wish to take note because similar planning opportunities arise because of the recent cut in capital gains tax, as the next section explains.

4.5 Exercise to benefit from capital gains rates

This section derives a condition on anticipated stock returns that make it worthwhile for the employee to exercise the option early so that subsequent appreciation in the stock is taxed at capital gains rather than ordinary rates.

To exercise the option and hold the stock, the employee must pay his employer the exercise price, X. Also, the employee must pay tax on the appreciation realized at the time of exercise. The employee pays tax (withheld at the time of exercise) of $(S_1 - X)t$. Thus, the amount the employee must borrow until the stock is sold is $X + (S_1 - X)t$. Assume the employee plans to hold the stock long enough to qualify for capital gains treatment. Further assume the option is sufficiently far in-the-money that the probability the option will be out-of-the-money over the remainder of its life is remote enough to be ignored. Let the price of the stock at the time the employee would exercise the option and sell the stock absent tax consideration be $\tilde{S}_2$. Let r be the optionee's net-of-tax cost of borrowing. Exercising the option at time 1 so that future appreciation is taxed at capital gains rates is preferred if

$$\tilde{S}_2 - (\tilde{S}_2 - S_1)g - [X + (S_1 - X)t](1 + r) > (\tilde{S}_2 - X)(1 - t).$$

The left-hand side of this expression represents the cash flows at time 2 from the employee's perspective if the option is exercised at time 1 and the stock acquired on exercise is held until time 2. There are no cash flows at time 1. At time 2, the employee receives $\tilde{S}_2$ on sale of the stock. The employee pays tax on appreciation of the stock from time 1 to time 2 at rate g. The capital gains tax due on the sale is $(\tilde{S}_2 - S_1)g$. Also, the

employee must repay the funds borrowed at time 1 to fund payment of the strike and withholding taxes, $[X+(S_1-X)t](1+r)$. For early exercise to be attractive, this amount must exceed the cash flow at time 2 assuming the option is held until that time. The proceeds from holding the option until time 2 are represented on the right-hand side of the inequality. Collecting terms reduces this expression to

$$(\tilde{S}_2 - S_1)(t-g) > [X + (S_1 - X)t]r.$$

The left-hand side represents the benefit from having the appreciation of stock from time 1 to time 2 taxed at capital gains rather than ordinary rates. The right-hand side of the expression represents the cost of borrowing the strike price and withholding tax until time 2. Dividing through by S_1, and collecting terms gives

$$\frac{\tilde{R}}{r} > \frac{t + \frac{X}{S_1}(1-t)}{t-g}, \tag{4}$$

where $\tilde{R} = (\tilde{S}_2 - S_1)/S_1$ is the pretax return on the stock from time 1 to time 2. This expression offers some additional intuitions. Holding other factors constant, the deeper the stock is in the money at time 1, the more attractive is early exercise. This is so because the right-hand side of (4) decreases in S_1.

This suggests a simple bound on the anticipated appreciation in the stock from time 1 to time 2 that is necessary for early exercise to be worthwhile when tax rates are constant over time. As S_1 increases, the right-hand side of (4) tends to $t/(t-g)$. If the anticipated appreciation in the stock, relative to the cost of borrowing does not exceed this ratio, then early exercise to benefit from taxation of future appreciation at the capital gains rate is not worthwhile. This bound holds for any current stock price and strike. If capital gains are not subject to tax and the strike price is negligible, then the bound is unity. This means the anticipated pretax return on the stock must exceed the net-of-tax cost of borrowing for early exercise to be worthwhile. However, if capital gains tax is substantial, then the hurdle may be high. For instance, if t is 40 percent and g is 20 percent, then the anticipated pretax return on the stock must be at least twice the net-of-tax cost of borrowing for early exercise to be worthwhile when the strike price

is negligible compared to the current market price.[11] The multiple must be higher when the strike price is substantial. For instance, if the strike price is one-third of the current market price and the pretax return on the stock is three times the net-of-tax cost of borrowing, early exercise is worthwhile.

5. Conclusion

Stock options are an increasingly common component of compensation at all levels in many organizations. An intriguing feature of most option grants is that employees may choose to exercise their options over a window that spans several years. The paper examines the causes and consequences of employee exercise decisions in three parts. First, the binomial model of stock price movements is used to explore how employee risk aversion influences option exercise and consequently affects option valuation. Next, the exercise activity of employees at eight corporations is described and related to the theoretical analysis. Finally, the impact of taxation on stock option is analyzed and compared to sample evidence. These three explorations highlight the richness and complexity of option compensation.

[11] This is often the case for employees holding options granted before, and expiring after, their employer's initial public offering.

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Table 1. Exercise activity by employee.

	10%	Median	90%	Mean
Fraction of options granted that are exercised by an employee at one time	0.25	0.50	1.00	0.61
Fraction of life elapsed at the time of exercise†	0.13	0.39	0.97	0.46
Fraction of life elapsed at the time of exercise*	0.32	0.82	0.99	0.74
Fraction of Black–Scholes value captured at time of exercise	0.47	0.76	0.92	0.72
Fraction of Barone-Adesi and Whaley value captured at time of exercise	0.44	0.80	0.99	0.75

† All observations.

* Includes only options for which more than 85 percent of the options' life elapsed before the end period for which exercise data was provided.

Data are based on employee-by-employee exercise activity. Decile, median and mean figures are computed over all option recipients at eight companies.

Table 2. Exercise activity by time since last vesting date and employee rank

		Fraction of exercise activity that follows the vesting date			
Employee Rank	N	30 days	90 days	180 days	365 days
Top 1%	2,400	.090	.203	.345	.609
Next 4%	9,398	.118	.258	.414	.726
Next 5%	9,438	.101	.234	.383	.765
Next 15%	20,553	.113	.265	.436	.804
Next 25%	21,004	.133	.301	.494	.832
Next 25%	12,431	.162	.332	.541	.862
Bottom 25%	6,734	.196	.390	.641	.883

This table displays the fraction of exercise activity that takes place within windows of 30, 90, 180, and 365 days following options vesting dates, broken down by employee rank. Ranks are computed according to the total number of options granted to an employee within company. The one percent of employees at each company who received the most options are reported on the first line of the table, and so on. N is the number of exercise events over which fractions are computed.

Table 3. International variation in the tax treatment accorded employee stock options.

	At time of vesting	*At time of exercise*	*At time of sale*
CANADA			
General Rule			
Employee	none	$-(S_e - X)g$	$-(S_s - S_e)g$
Employer	none	none	none
Canadian Controlled Private Corporation Options			
Employee	none	none	$-(S_s - X)g$
Employer	none	none	none
SWEDEN			
General Rule			
Employee	$-F_v t$	none	$-(S_s - S_e - F_v)g$
Employer	none	none	none
UNITED KINGDOM			
General rule:			
Exercise satisfied by issuance of new shares			
Employee	none	$-(S_e - X)t$	$-(S_s - S_e)g$
Employer	none	none	none
Exercise satisfied using existing shares			
Employee	none	$-(S_e - X)t$	$-(S_s - S_e)g$
Employer	none	$(S_e - X)T$	none
"Approved" Schemes:			
Exercise satisfied by issuance of new shares			
Employee	none	none	$-(S_s - X)g$
Employer	none	none	none
Exercise satisfied using existing shares			
Employee	none	none	$-(S_s - X)g$
Employer	none	$(S_e - X)T$	none
UNITED STATES			
Non-qualified stock option (NQO)			
Employee	none	$-(S_e - X)t$	$-(S_s - S_e)g$
Employer	none	$(S_e - X)T$	none
Incentive stock option (ISO)			
Employee	none	none	$-(S_s - X)g$
Employer	none	none	none

F_v Assessed value at the time of vesting
S_e Stock price on the day the option is exercised
S_s Stock price on the day shares received under option are sold
X Exercise price of the option
T Corporate tax rate
t Personal tax rate
g Personal capital gains tax rate

Assumes options are granted at-the-money. Positive figures are reductions in taxes otherwise payable. Negative figures are incremental tax payments. Only NQOs allow the employer to claim a tax deduction.

Table 4. Effect of tax rate changes on employer and employee exercise preferences.

Situation		*Preference*		*Defining Criteria*	*Necessary condition for gains from aligning preferences*
		Early Exercise	Exercise at Maturity		
1	Employer	X		$\frac{S_1-X}{W_1^r} \leq \frac{1-T_2}{1-T_1}$	
	Employee	X		$\frac{1-t_2}{1-t_1} \leq \frac{S_1-X}{W_1^e}$	
2	Employer	X		$\frac{S_1-X}{W_1^r} < \frac{1-T_2}{1-T_1}$	Paying the employee F
	Employee		X	$\frac{S_1-X}{W_1^e} < \frac{1-t_2}{1-t_1}$	to induce early exercise is worthwhile if $\frac{1-t_2}{1-t_1} < \frac{1-T_2}{1-T_1}\frac{W_1^r}{W_1^e}$
3	Employer		X	$\frac{1-T_2}{1-T_1} \leq \frac{S_1-X}{W_1^r}$	
	Employee		X	$\frac{S_1-X}{W_1^e} \leq \frac{1-t_2}{1-t_1}$	
4	Employer		X	$\frac{1-T_2}{1-T_1} < \frac{S_1-X}{W_1^r}$	Paying the employee F
	Employee	X		$\frac{1-t_2}{1-t_1} < \frac{S_1-X}{W_1^e}$	to exchange American options for European options is worthwhile if $\frac{W_1^r}{W_1^e}\frac{1-T_2}{1-T_1} < \frac{1-t_2}{1-t_1}$

The employee and employer prefer the same exercise policy in Cases 1 and 3. In Cases 2 and 4, the employer and employee have opposite preferences. Depending on the values assigned to the option by the employee and employer and the tax rates, it may be worthwhile for the employer to pay the employee an amount $F = W_1^e(1-t_2)/(1-t_1) - \max(S_1 - X, 0)$ in exchange for a commitment to (i) exercise before the tax rate change (Case 2), or (ii) to postpone exercise until after the tax rate change (Case 4).

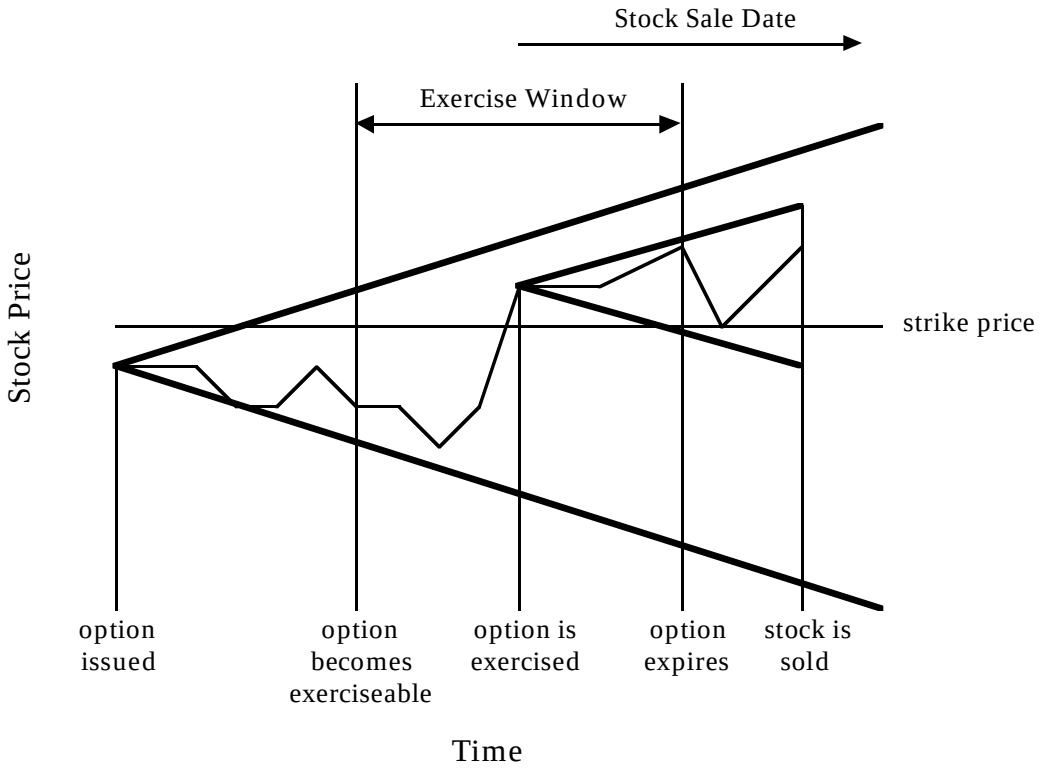

Figure 1. Nature of employee stock options.

Employee stock options often are not exercisable for some years after issuance. The option may be exercised before expiration. The employee may sell the stock at any time after she exercises the option.

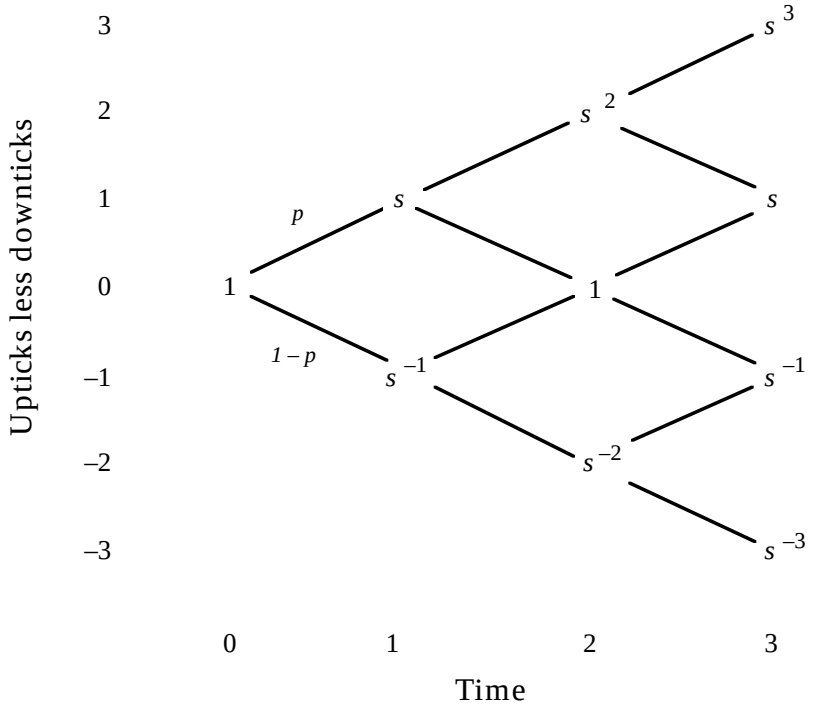

Figure 2. The binomial model of stock price evolution.

An ingrown tree depicts stock price movements. At every node, the probability of an uptick is p. The probability of a downtick is $1 - p$. On an uptick (downtick), the stock price increases (decreases) by a factor of s ($1/s$).

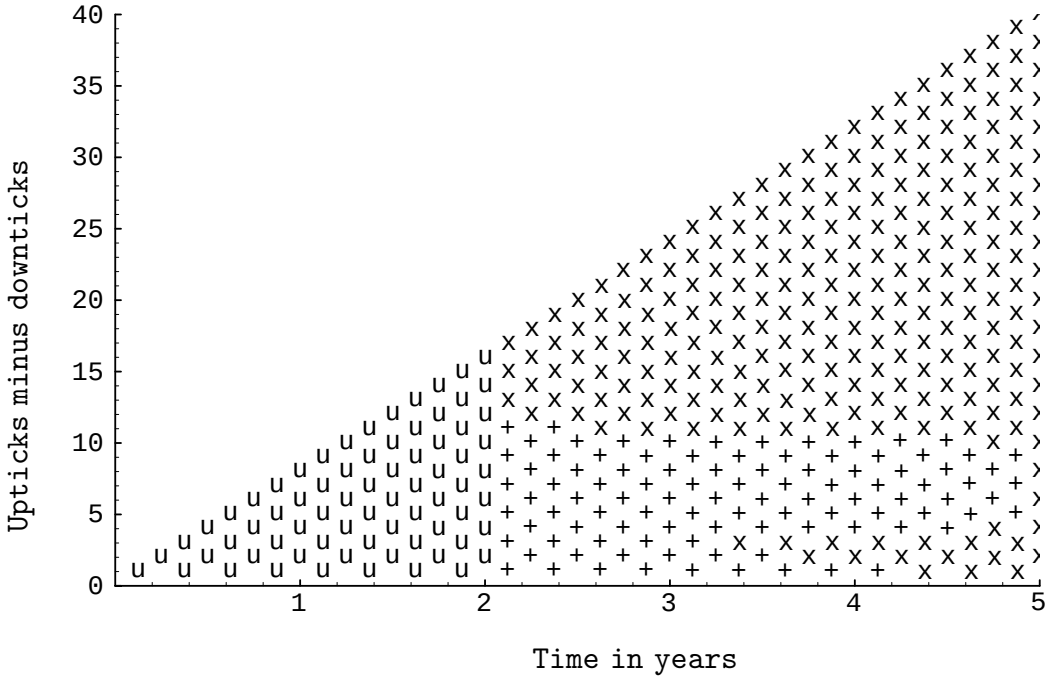

Figure 3. Graphical representations of optimal exercise policy.

This figure plots the optimal exercise policy for an ESO that matures after 5 years and is owned by a risk averse employee. The employee is assumed to have a terminal utility for wealth given by $U(W) = W^{1/4}$. The option does not vest until two years after the grant date. A riskless asset offering the same expected return as the stock is available. The optimal policy in (time, stock price) space is shown by

- `x` Exercise;
- `u` The employee cannot exercise the option because it has not vested;
- `+` Hold the option until next period.

A forty-step binomial model with parameters $p = .558926$ and $s = 1.1119$ approximates the evolution of the price of a stock with annual mean return of $\mu = .1$ and volatility of $\sigma = .3$.

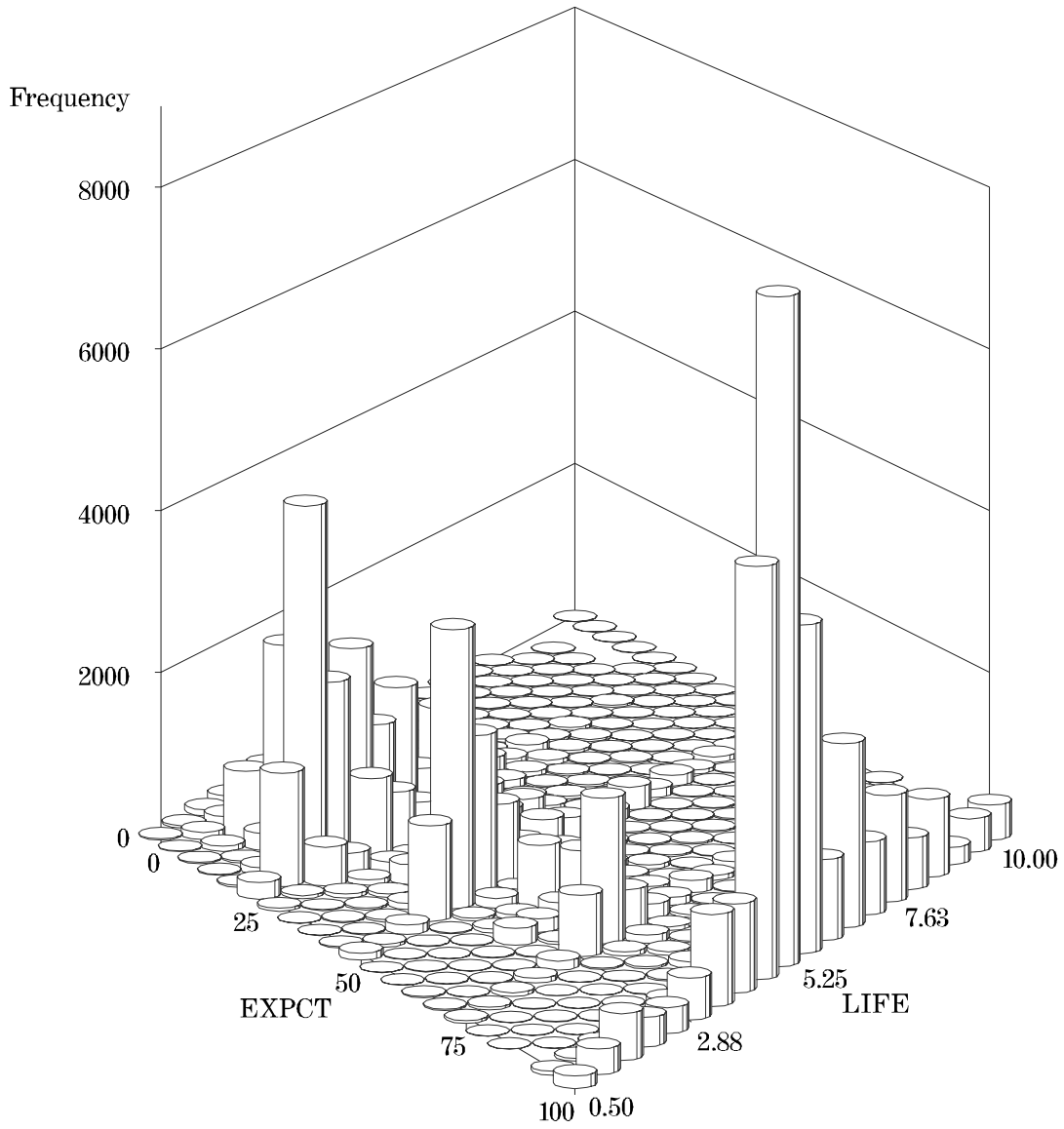

Figure 4. Frequency of exercise as a function of elapsed life and percentage of options granted

EXPCT is the percentage of options issued to an employee in one grant that are exercised together. LIFE is the elapsed life of the option in years. There are 85,853 events in which employees exercise options in our data set. The LIFE axis is divided into intervals that represent six month periods of time. The EXPCT axis is divided into intervals that represent ranges of five percent. 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. Because the most common vesting schedule is 25% per year over four years, this pattern suggests many employees exercise options soon after they vest.

Figure 5

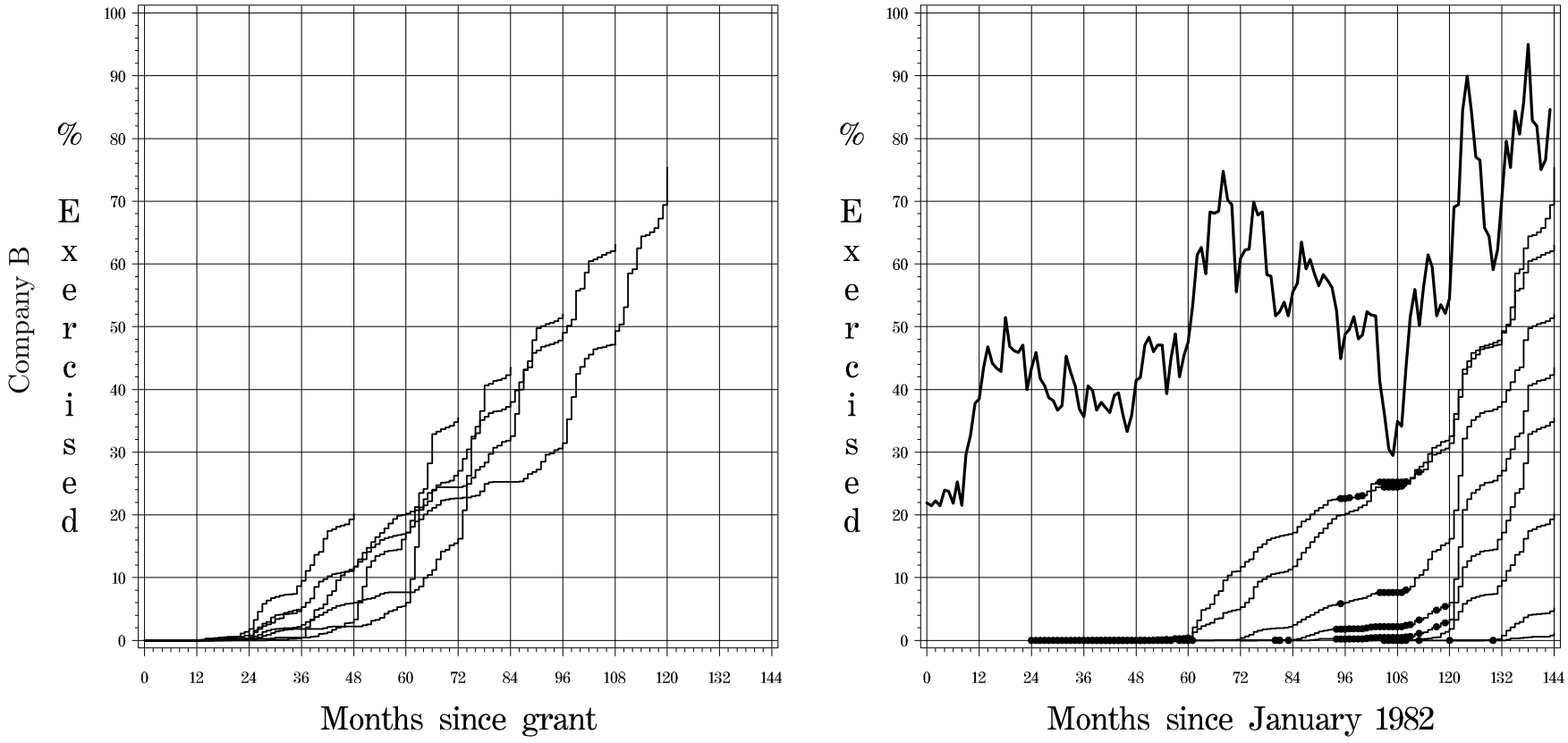
Company B
% Exercised
100
90
80
70
60
50
40
30
20
10
0
0 12 24 36 48 60 72 84 96 108 120 132 144
Months since grant
% Exercised
100
90
80
70
60
50
40
30
20
10
0
0 12 24 36 48 60 72 84 96 108 120 132 144
Months since January 1982

Figure 5 (continued)

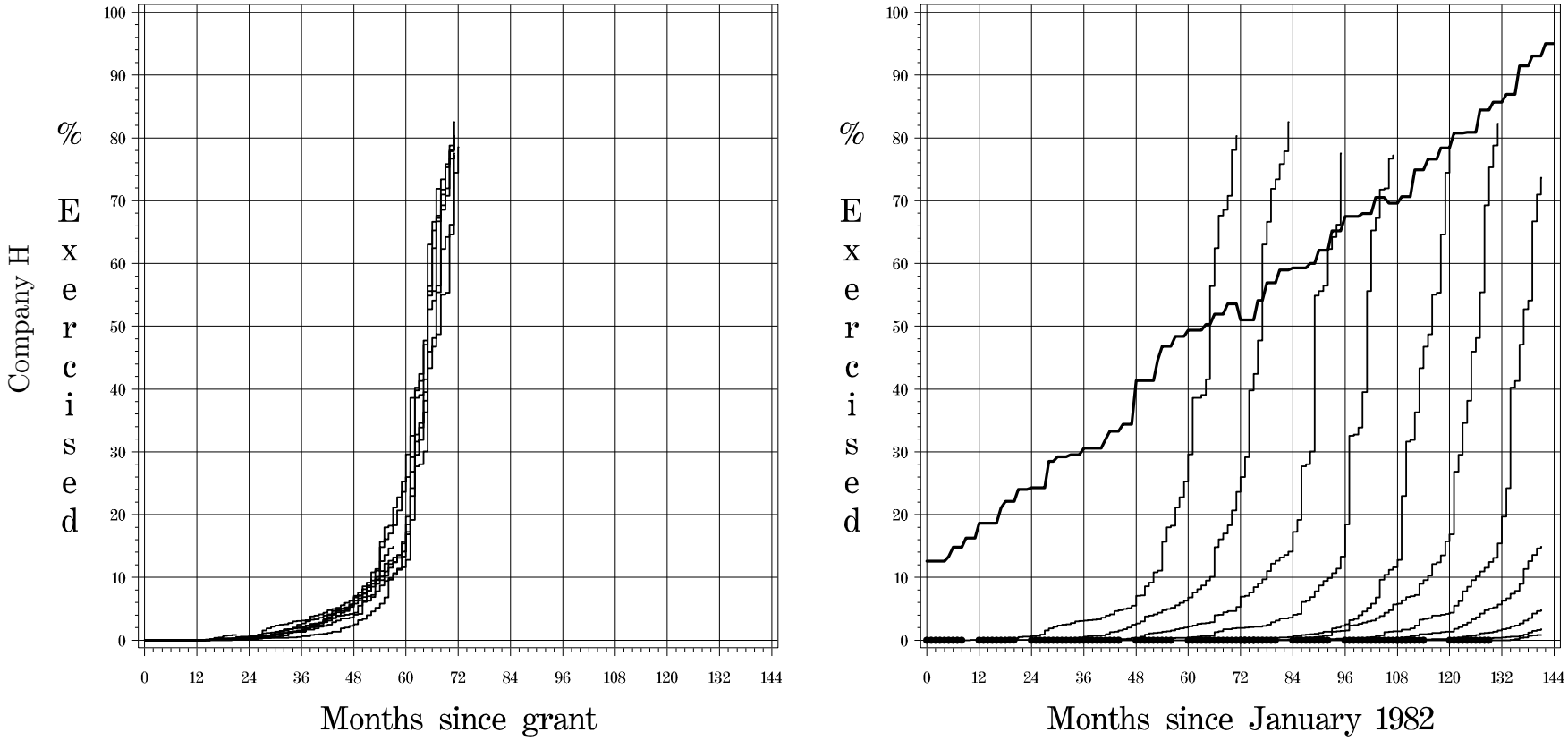

Figure 5. Cumulative exercise over time: Companies B and H

Left-hand Panels: Plot of cumulative options exercised as a percentage of options granted. Time is measured from the grant date. All options granted in the same calendar year are treated as a single grant. Each line corresponds to the options granted in a single calendar year. Data were computed by cumulating the options exercised each month within grant year and dividing by the total options granted in the grant year. Right-hand Panels: As in the left-hand panels, thin lines plot cumulative options exercised as a percentage of options granted, but time is measured from January 1982. Black circles overlaid on the thin lines indicate periods when the options were out of the money. The thick black line plots mid-month stock prices.

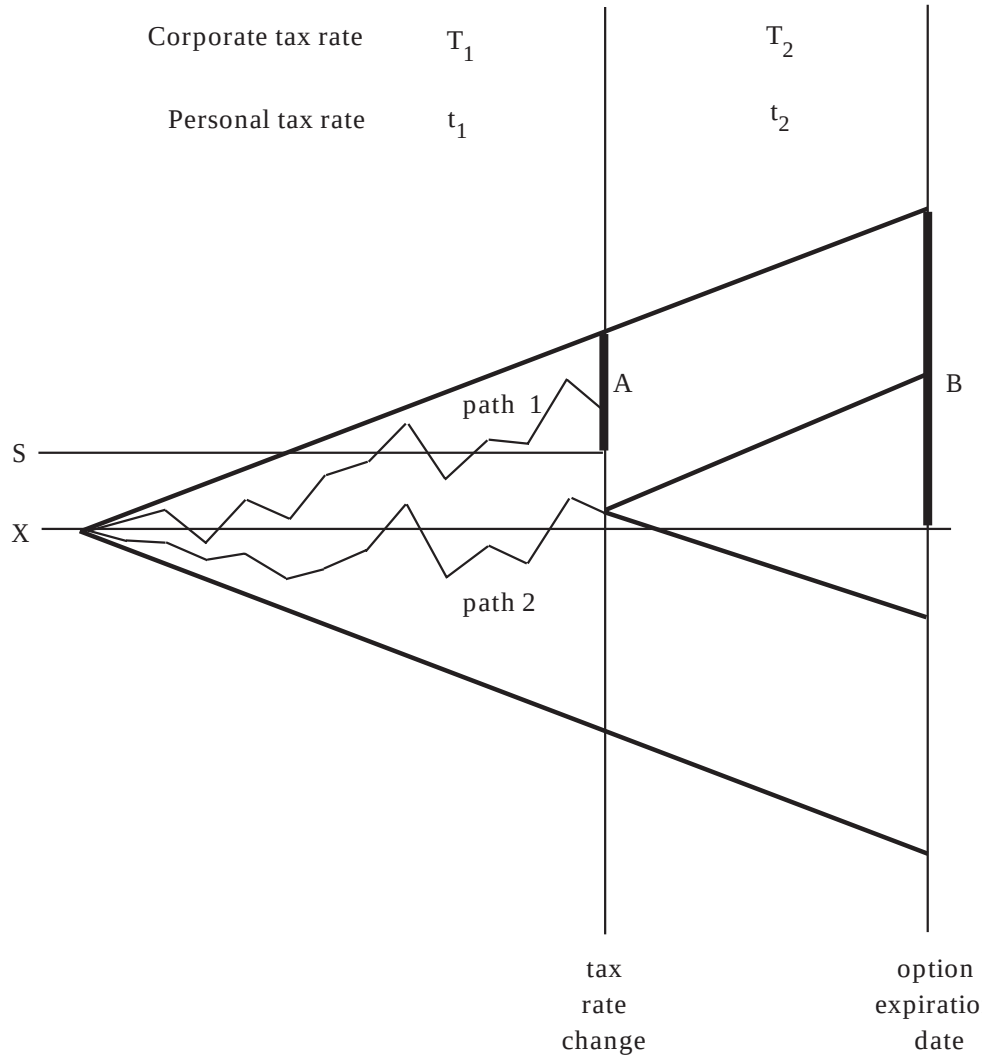

Figure 6. Relationship between stock price and exercise decisions.

Consider an option on a stock that does not pay dividends. In the figure, X is the strike price and S is the least stock price at which exercise before the tax rate increase is worthwhile. The horizontal axis represents time. The vertical axis represents stock price. A risk-neutral employee who does not face liquidity constraints may choose to exercise an option just before a tax rate increase (region A) provided the stock price is high. Otherwise, the employee will exercise the option at maturity if it is in the money (region B). The exercise decision depends on the dynamics of the stock price process the options' characteristics. It is not optimal to exercise near-the-money options, but it may be optimal to exercise deep-in-the-money options should be exercised.

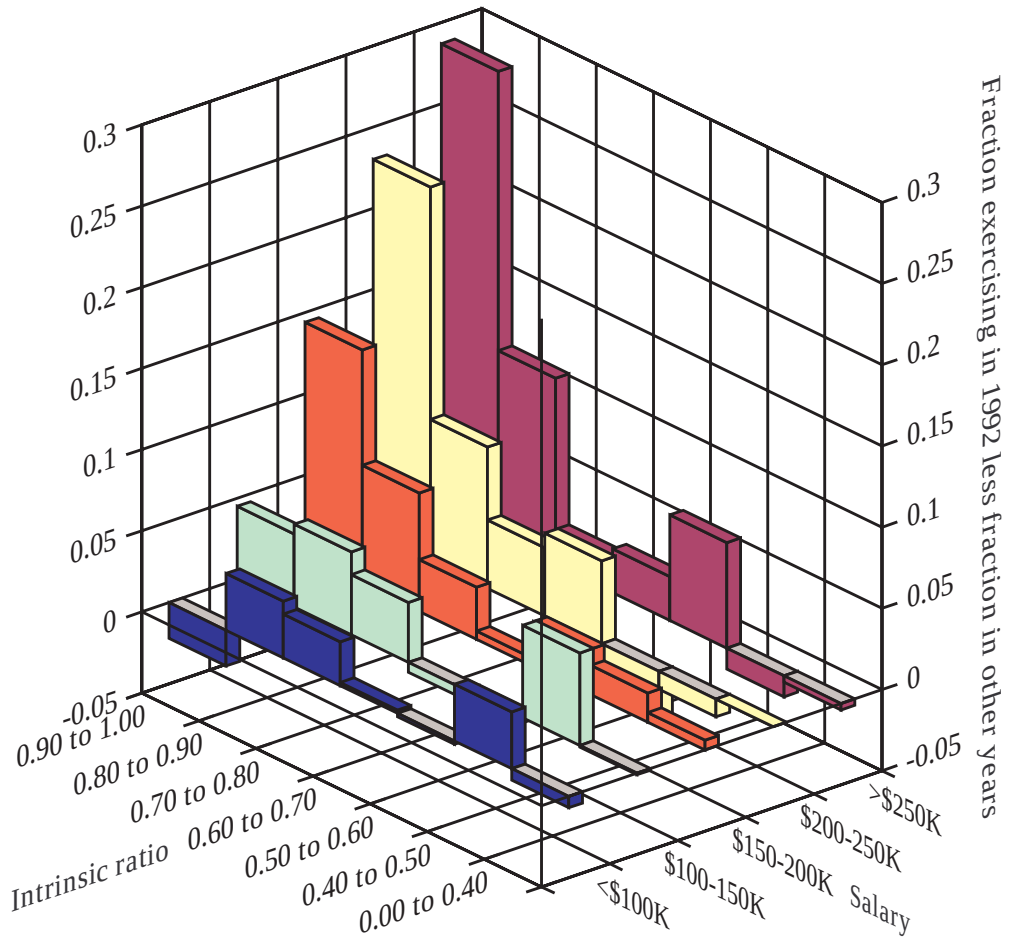

Figure 7. Increase in exercise before a tax rate increase.
This figure plots differences between the fraction of options exercised in the period November 4 to December 31, 1992 by employees at four companies and the fraction exercised in the corresponding 58 day periods in 1990, 1992, and 1993. The frequency of exercise is broken down by the salary level of the employee and by the intrinsic ratio of the option, $(S - X)/W$. The intrinsic ratio measures the fraction of the option's total value that is captured on exercise. Total value is the Barone-Adesi and Whaley (1987) value of the option.