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Executive Compensation Using Relative-Performance-Based Options: Evaluating the Structure and Costs of Indexed Options

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Abstract

This paper examines how an option plan that rewards managers for firm performance relative to some market or industry benchmark should be structured, and gauges the deadweight costs of such a plan. Relative-performance-based compensation advocates contend that conventional stock options do not adequately discriminate between strong and weak managers, typically suggesting "indexed options," that is, options with an exercise price linked to a market or industry index, as a remedy. A close examination of indexed options, however, reveals a fundamental problem: indexed options do *not* function as intended. Instead, their payoff remains highly sensitive to market or industry price movements. This paper proposes an alternative option design that *does* remove the effects of the desired benchmark. This structure uses an option with a fixed exercise price, where the underlying asset is a *portfolio* comprised of the firm's stock hedged against market and industry price movements. The paper then compares the deadweight cost of this performance-benchmarked option to that of a conventional stock option. Deadweight costs inevitably accompany any equity-based compensation program, because the firm's managers *must* be exposed to firm-specific risks to properly align incentives, and this forced concentrated exposure prevents managers from optimal portfolio diversification. Undiversified managers are exposed to the firm's total volatility, rather than the smaller systematic portion faced by the well-diversified investor, meaning that they will always value their stock- and option-based compensation at less than its market value. I estimate the cost of this lost diversification, and find that, perhaps surprisingly, the gap between the firm's cost (the market value) and the manager's private value of an option is 57% *greater* for relative-performance-based options than for conventional options. The relative-performance based options have larger deadweight costs because, by design, they strip away the manager's exposure to all systematic risk, leaving her with a portfolio with an expected return no better than the risk-free rate. The paper discusses the practical implications of this analysis for firms adopting relative-performance-based option plans.

I. Introduction

One unintended consequence of stock and option-based compensation is that in a strong stock market, it has the potential to indiscriminately reward both strong and weak managers alike. In such a market, stock prices tend to increase, even for firms underperforming their competitors. The sense that managers with less-than-stellar performances are reaping enormous payoffs has led reformers to suggest "indexed options," that is, options whose payoff is linked to some sort of market or industry-based index. [1] This paper investigates the interrelated issues of how, and indeed whether, to use indexed options.

Executive stock options that explicitly tie managers' pay to the firm's performance relative to a market or industry benchmark are just beginning to be used in practice, and much work remains on how to practically implement such a system.[2] The paper begins by evaluating an indexed option plan structured along the lines most frequently proposed by indexed performance advocates, where the option's exercise price changes to reflect the performance of the benchmark market or industry index.[3] As it turns out, this prototypical design does *not* remove the effect of the benchmark index from compensation: as the market increases, the value of the variable-exercise-price option will, too.[4] This paper presents an alternative design that achieves the desired effect of rewarding managers *only* for performance that is not due to overall gains in the market or industry. Instead of using the firm's stock as an underlying asset, this alternative design employs a performance-benchmarked portfolio. This performance-benchmarked portfolio consists of the firm's stock, hedged against market and industry movements. Under this proposed structure, the value of the *portfolio* changes to reflect the firm's performance, net of market and industry effects, while the *exercise price* remains fixed.

[1] See, for example Akhigbe and Madura (1996), Barr (1999), Johnson (1999), Johnson and Tian (2000), Kay (1999), Nalbantian (1993), Rappaport (1999), Reingold (2000), Schizer (2001).
[2] Level 3 Communications, for example, is one of the few firms to implement an indexed option system (see Meulbroek (2001b)). Rappaport (as quoted in Barr (1999)) predicts that indexed options "…will be easier to sell once the market cools. In a bull market, you want to be paid for absolute performance, but in a more stable or bear market, you want to be paid for relative performance."
[3] See sources listed in footnote 1.

The paper then proceeds to examine the costs associated with these options on the performance-benchmarked (i.e. indexed) portfolio. While the incentive-alignment benefits of indexed options have been widely-discussed, the costs have not. Equity-based compensation inevitably imposes deadweight costs on the firm because it drives a wedge between the firm's cost of awarding compensation (i.e. its market value), and the value placed on that compensation by managers. To align incentives, managers *must* be exposed to firm-specific risk. This exposure to firm-specific risk reduces managers' ability to diversify their portfolios. Loss of diversification is costly; it leaves managers exposed to the firm's full risk, when expected returns "compensate" them only for the systematic portion of that risk. Managers will therefore always value their equity-linked compensation at less than its market value. The greater the amount of the manger's wealth invested in the firm, the greater the lost-diversification cost imposed on that manager.

In practice, the costs associated with the manager's loss of diversification can be large and substantial. In earlier work, Meulbroek (2001a), I have estimated that the private value that managers place on conventional executive stock options is roughly half of their market value in rapidly-growing entrepreneurially-based firms, such as Internet-based firms. Even for less-volatile NYSE firms, the deadweight loss associated with stock options is 30% of their market value. In this paper, I explore whether the lost-diversification costs associated with a performance-benchmarked portfolio (i.e. "indexed") option plan are greater or less than the lost-diversification costs associated with a conventional option plan.

Perhaps surprisingly, I find that the deadweight costs associated with an option on the performance-benchmarked portfolio *exceed* those associated with a conventional option plan. For the set of firms tracked by Value Line, the "efficiency" of the option on the market and industry-adjusted performance-benchmarked portfolio is 21% lower than the

[4] This effect arises because the options are homogeneous of degree one with respect to strike price and exercise price.

efficiency level of a conventional option. Efficiency drops because benchmarking, by design, isolates firm-specific performance, removing some or all of the systematic component of firm returns from a manager's compensation. As a consequence, performance-benchmarked portfolio options remove the component of firm returns correlated with the market, that is, the exact component that provides some degree of "diversification" to the manager. I use this insight to investigate the best way to implement a performance-benchmarked "indexed option" compensation plan, ultimately concluding that the performance-benchmarked option compensation plan should be supplemented with a cash grant, rather than by an increase in the number of options awarded relative to a conventional option plan, as many indexed option advocates recommend.[5]

The paper proceeds as follows. Section II further describes the motivation behind relative performance compensation, the extent to which it is used in practice, and the need for restructuring the type of indexed option plan typically proposed by relative-performance compensation advocates. Section III proposes an alternative to the indexed option with a variable exercise price, namely, an option on a performance-benchmarked portfolio. This market- and industry-adjusted option truly rewards for relative performance. Section IV outlines introduces a method to measure the deadweight costs associated with a performance-benchmarked option, and Section V estimates those costs for NYSE, Amex, and Nasdaq firms, comparing them to the costs associated with conventional options. Section VI concludes.

[5] See, for example, Rappaport (1999) or Reingold (2000) for arguments in favor of an indexed option adopter awarding a greater number of indexed options than would be awarded under a conventional plan.

I. Paying Managers for their Relative Performance

A. The conceptual basis for performance indexing

Compensation systems have three functions: to compensate managers for completed work, to reduce principal-agent costs by more closely aligning managers interests with those of shareholders, and to retain the manager. Compensation that performs one of these functions effectively may not be as good at fulfilling the other functions of a compensation system. Stock options, for example, are used to align incentives. However, a firm that has no need to create such incentive alignment would be very unlikely to use stock or stock options to compensate its managers, for better ways exist. Cash compensation, for example, is one form of compensation that a firm could use when incentive alignment is deemed relatively unimportant. Cash avoids the deadweight costs that accompany any equity-based compensation plan, deadweight costs that arise because the same exposure to firm-specific risk that aligns incentives also compels managers to hold a less-than-fully-diversified portfolio. This loss of diversification is costly for managers, who now must bear both systematic and non-systematic risk. By using cash, a firm avoids such costs. While stock options can surely can be used as a form of payment to compensate managers, and, when combined with vesting requirements, stock options can also help with retention, stock options are not the most efficient form of compensation to achieve these goals: their comparative advantage lies in their ability to align incentives.

At times, however, conventional stock options are *not* an effective way to align incentives. Effective incentive alignment requires that the value of the options increase with managerial effort and ability. When managers' efforts have little affect on firm performance, managers have little incentive to work hard. Critics of options assert that strong stock market performance has weakened the hoped-for link between managerial pay and firm performance. Contributing to this weaker pay-performance relationship are higher levels of market volatility, which have also increased the cost of exposing managers to firm-specific risk, an exposure that is not particularly helpful incentive-alignment tool when managers have limited influence over the volatility. Critics of traditional stock option plans question their effectiveness, noting that

> "In the bull market of the past decade, many companies generously compensated management even when the companies underperformed the market. Significant unearned compensation not only wastes shareholders' money but also sends an inappropriate motivational message. It increases the skepticism of employees, customers, the press, and the public at large, giving the impression that compensation systems represent a kind of lottery rather than a serious way to reward performance. At the other extreme, a poor overall market or weakness in particular sectors provides few opportunities for companies to use conventional stock options to reward real performance." Johnson (1999)

Or, as Warren Buffet laconically puts it, "… [stock options] are wildly capricious in their distribution of rewards, inefficient as motivators, and inordinately expensive for shareholders."[6] Academic research, too, has noted the problems with traditional stock options: Gibbons and Murphy (1990), for example, suggest that compensation contracts based upon firm performance, not adjusting for industry or market performance, "…subject executives to vagaries of the stock and product markets that are clearly beyond management control."[7] Such observations have renewed the call for compensation based upon relative performance. Relative- performance-based compensation aims to tighten the link between managerial efforts and compensation by rewarding managers only for that portion of performance under their control, filtering out the effect of performance that derives from factors outside managers' control, such as industry-wide or market-wide gains or losses.

Options indexed to firm performance are one way to implement a relative-performance-based compensation system. Until recently, however, the same strong stock market performance that has rewarded managers for stock price performance unrelated to their own efforts has also impeded their acceptance of a compensation plan based on relative performance. Managers are reluctant to give up the potentially huge rewards conferred by the bull market, especially when they perceive the probability of a downturn in the stock market as being low.[8] To be sure, relative-performance-based compensation *does* have the advantage that it protects managers during market downswings. Under traditional

[6] Cairncross (1999)
[7] Gibbons and Murphy (1990) p. 31-S

stock option plans, adverse market performance results in vastly reduced compensation for managers. Relative-performance based compensation protects managers against such market downturns; even if the market declines, managers can still be well-compensated if they outperform their market or industry benchmark.[9] This protection, of course, is not particularly valuable to managers who view poor stock market performance as a remote possibility, a view that, at least until recently, seemed to be the prevailing managerial outlook.

While managerial support for compensation based upon relative performance has been sparse, the theoretical underpinnings for this type of compensation are compelling. Murphy (1998) presents the framework supporting performance-based compensation generally, and relative-performance-based compensation more specifically. The justification for relative-performance-based compensation rests upon the observation that the incentive induced by a compensation scheme depends upon how “informative” the measure used to reflect performance is. In other words, an effective managerial incentive system requires a strong link connecting managers’ effort and productivity to observable firm performance, and, as Holmstrom (1982) argues, relative-performance-based compensation provides just such a link by allowing principals to extract better information about managerial effort and performance.

B. The extent of relative-performance-based compensation

Relative performance based compensation can take many forms, implicit or explicit, in the manager’s compensation contract. A substantial empirical literature explores whether companies’ compensation schemes reflect implicit relative performance compensation. Murphy (1998) describes and analyzes much of this literature, reporting that such implicit compensation schemes exist, but may not predominate. Gibbons and Murphy (1990), for example, report that firms do compensate their CEO’s based upon relative performance. They find that the salary and bonus of CEOs appeared to be positively and significantly

[8] The current drop in the prices of technology stocks may alter that perception.
[9] Even under conventional plans, managers have some degree of protection against falling markets. When options move too far out-of-the-money, firms sometimes either re-strike the options, or issue new options

related to firm performance, but negatively and significantly related to market and industry performance. Antle and Smith (1986) provide limited evidence that firms compensate managers based upon relative performance, and Himmelberg and Hubbard (2000) observe relative performance evaluation compensation among smaller firms with "less-highly skilled" CEOs. In contrast, Bertrand and Mullainathan (1999) report that CEOs are paid for market-wide and industry movements (what they term "luck"), but the better-governed firms compensate their CEOs less for such movements than other firms. Sloan (1993)'s work also supports the hypothesis that firms base CEO compensation, at least in part, on earnings, as way to help filter market-wide movements from compensation. Other researchers, however, find less evidence of implicit relative performance-based compensation. For instance, Aggarwal and Samwick (1999), investigating pay-performance sensitivities, uncover little evidence that compensation contracts reward relative performance, as do Janakiraman et al. (1992).

Firms are not limited to implicit relative performance plans. Explicit compensation contracts, such as options indexed to an industry or market benchmark, can be used to reward managers for their relative performance. While indexed options are frequently proposed as a straightforward way to measure relative performance, they seem to be little used in practice. Level 3 Communications, a telecommunications company, is currently the only U.S. firm that has implemented an indexed option program. [10] Contributing to their rarity is their accounting treatment (i.e. the value of the options are deducted from the firm's earnings) and managers' reluctance to consent to such plans.[11] Nonetheless, the

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with lower strike prices. See Carter and Lynch (2001), Jin and Meulbroek (2001), Gilson and Vetsuypens (1993), Chance et al. (2000), Brenner et al. (2000), and Saly (1994)

[10] See Meulbroek (2001b).

[11] Hall and Liebman (1998) comments on the rarity of indexed options, characterizing this scarcity as puzzling. Levmore (2000) explores how risk might affect the use of indexed options, and Schizer (2001) points to the tax consequences of indexed options Rappaport (1999) discusses the unfavorable accounting treatment of indexed options, suggesting that such treatment is a misplaced concern: "bad accounting policy should not be allowed to dictate compensation." Referring mostly to compensation based upon performance relative to co-workers, Gibbons and Murphy (1990) suggest potential costs associated with such relative performance evaluation: "basing pay on relative performance generates incentives to sabotage the measured performance of co-workers (or any other reference group), to collude with co-workers and shirk, and to apply for jobs with inept co-workers." Continuing on, however, they also state that these reasons are less important for top managers, such as CEOs, who "…tend to have limited interaction with CEOs in rival firms, [so] sabotage and collusive searching seem unlikely." Oyer (2000) attributes the lack of observable relative performance evaluation to what he terms the "participation constraint," that is, the

magnitude of recent conventional option grants has intensified the call for some form of performance indexing.

C. Structural limitations: indexed options with variable exercise prices <u>are</u> sensitive to market and industry price movements

Advocates of indexed options generally propose a structure that ties the option's exercise price to a selected index. Rappaport (1999) describes such a plan:

> "Let's assume that the exercise price of a CEO's options are reset each year to reflect changes in a benchmarked index. If the index increases by 15% during the first year, the exercise price of the option would also increase by that amount. The option would then be worth exercising only if the company's shares had gone up by more than 15%. The CEO, therefore, is rewarded only if his or her company outperforms the index."

To price the indexed option described above, one can use the Margrabe-Fischer-Stulz approach recently outlined by Johnson and Tian (2000). [12] The Margrabe-Fischer-Stulz formula values a European option to give up an asset worth S_1 and receive in return an asset worth S_2 (for our purposes S_1 represents the firm's initial stock price adjusted for market and/or industry movements, that is, the strike price of the option; S_2 represents the firm's stock price without any such adjustments). They assume that S_1 and S_2 both follow geometric Brownian motion with volatilities s_1 and s_2, and that the instantaneous correlation between S_1 and S_2 is r, and the yields provided by S_1 and S_2 are q_1 and q_2. $N(\cdot)$ represents the standard normal cumulative distribution function, and T represents the time remaining until option maturity. The value of the option at time zero is then:

$$S_2 e^{-q_2 T} N\left(d_1\right) - S_1 e^{-q_1 T} N\left(d_2\right)$$

market return proxies for the manager's outside opportunities, and one therefore would expect to find the manager's wages correlated with the market return. See also Murphy (1998) for a detailed discussion of the paucity of indexed option or relative performance plans more generally.

[12] Merton (1973)'s option-pricing model incorporates stochastic interest rates, which is functionally-equivalent to an option-pricing model with a stochastic exercise price. Margrabe (1978) models the option to exchange one asset for another where the value of both assets is stochastic and in contemporaneous work Fischer (1978) prices an indexed bond. Stulz (1982) uses a similar model to price an option on the minimum or the maximum of two risky assets. Johnson and Tian (2000) adopt this approach in their paper on indexed stock options, as do Angel and McCabe (1997).

where

$$d_1 = \frac{\ln(S_2 / S_1) + (q_1 - q_2 + s^2/2)T}{s\sqrt{T}}$$

$$d_2 = d_1 - s\sqrt{T}$$

and

$$s = \sqrt{s_1^2 + s_2^2 - 2 r s_1 s_2}$$

The variable s is the volatility of S_1/S_2. This option price is the same as the price of S_1 European call options on an asset worth S_1/S_2 when the strike price is 1, the risk-free interest rate is q_1, and the dividend yield on the asset is q_2.

As the above equation illustrates, the price of the option increases proportionally to its stock price and its exercise, that is, the option is homogeneous in degree one with respect to the stock price and the exercise price. For example, suppose the stock price increases by 10% (that is, S_2 increases to 1.1 S_2), and the benchmark index also increases by 10% (S_1 increases to 1.1 S_1). In this instance, the manager has not outperformed the benchmark, so the value of the option *should* remain unchanged. However, the value of an option designed with a variable exercise price does not remain unchanged, as intended by the proponents of indexed options. Instead, the value of the option *increases* by 10%, just the effect the proponents of indexed options hoped to eliminate. By substituting the new prices in the equation above, one can clearly see that this unintended outcome indeed arises. Specifically, under the newly changed prices, the value of the option will be:

$$(1.1 \times S_2)\, e^{-q_2 T} N(d_1) - (1.1 \times S_1)\, e^{-q_1 T} N(d_2)$$

where d_1 *and* d_2 remain unchanged. The 1.1 can be factored out, so that the value of the option after the price movements outlined above is:

$$1.1 \times [S_2 e^{-q_2 T} N(d_1) - S_1 e^{-q_1 T} N(d_2)]$$

or 10% above its initial value. That is, the value of the option has *increased* by 10% even though the stock *failed* to outperform the market index.

This proportionate response of the option price to like changes in the exercise and stock price defeats the intended outcome. Recall that the proponents of indexed options seek an instrument that does *not* increase in value when the stock price appreciates the same amount as the designated index. Therefore, an option with a variable stock price linked to an index is *not* an effective way to implement a relative performance compensation system.[13] Below I use an indexed portfolio-based approach to solve for an option that is *not* sensitive to movements in the index, referring to this proposed solution as an option on a "Performance-Benchmarked Portfolio," where the value of this portfolio is hedged against changes in the designated index.

II. Designing a Relative Performance Compensation System

One way to devise an option plan that rewards managers only for their relative performance is to base the option on a *portfolio* whose value depends upon relative performance. The idea underlying the portfolio-based indexed option, which I refer to as an option on a *Performance-Benchmarked Portfolio* is straightforward. The value of this portfolio is initially set to the firm's stock price. The value of the portfolio then either increases by the percentage that the firm outperforms its market- or industry-benchmark or decreases by the percentage that the firm underperforms its market- or industry-benchmark. The exercise remains fixed and, following standard practice, equals the firm's stock price at the time the option is awarded.

Notation:

Let $e^{r_f} \equiv (1 + R_f)$ where R_f represents the riskless arithmetic return, and r_f is therefore its continuously-compounded equivalent.

$e^{r_j} \equiv$ (1 + yearly expected rate-of-return of security *j* under CAPM pricing)

$e^{r_i} \equiv$ (1+ yearly expected rate-of-return for industry *i* under CAPM pricing)

[13] It is possible to alter the terms of an indexed option with a variable exercise price to mitigate this unintended consequence. Level 3 Communications, for instance, uses a "multiplier" in the construction of its outperform options. When the firm's stock return and the index's stock return increase by the same amount, Level 3 multiplies the value of the option by zero. If the firm's stock outperforms the index, the

$\left(r_m - r_f\right) \equiv$ market risk premium (continuously-compounded)

$r_m \equiv$ expected market return (continuously-compounded)

$s_m \equiv$ market volatility

$b_j \equiv$ firm *j*'s beta from CAPM

$s_j \equiv$ firm *j*'s volatility

$s_i \equiv$ industry *i*'s volatility

$b_i \equiv$ industry *i*'s beta relative to the market

$r_{jm} \equiv$ correlation between firm *j* returns and market returns

$r_{im} \equiv$ correlation between industry *i* returns and market returns

$h_{ji} \equiv$ correlation between industry *i's* returns and firm *j's* ex-market returns

We assume that CAPM in continuous-time obtains[14], so

$$r_j = r_f + b_j\left(r_m - r_f\right) \tag{1}$$

$$r_i = r_f + b_i\left(r_m - r_f\right) \tag{2}$$

A. Designing a Portfolio Hedged Against Market Movements[15]

Let the value of a portfolio of the firm's equity return hedged against market movements be denoted:

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value of the indexed option is multiplied by a number that depends on the degree of outperformance. This construction effectively increases the leverage of the option.

14 This assumption is consistent with the underlying assumption of the Black-Scholes-Merton option-pricing model, which we use later to value the executive stock options. Unlike the original single-period discrete-time version of the CAPM, the continuous-time version of the CAPM and its implied mean-variance optimizing behavior is consistent with limited-liability, lognormally-distributed asset prices, and concave expected utility functions. See Merton (1992) and Black and Scholes (1973). In the Black-Scholes model, and in continuous-time portfolio theory, the security market line relation is expressed in "instantaneous" expected-rates-of-return (i.e. exponential, continuous-compounding). Use the CAPM in this derivation is not essential. Any asset-pricing model could be substituted.

15 While we do not show the derivation here, one could, in a similar fashion, one construct a portfolio hedged solely against industry-wide movements.

$P_j(t) \equiv$ value of the "ex-market" portfolio for stock j

where "ex-market" means that the portfolio is hedged against market movements. Consider a strategy that is long the stock and short the market, and is constructed to have a zero-beta. Specifically, the portfolio, P_j, is long fraction 1.0 in stock j, short fraction b_j in the market, and is long fraction b_j in the riskless asset, as displayed in Figure 1.

Establishing the Market-Adjusted Portfolio at time t=0		
Asset	**Long Position**	**Short Position**
Stock	V_j	
Market		$-b_j V_j$
Riskless Asset	$b_j V_j$	
Cost of Long or Short Position	$V_j + b_j V_j$	$-b_j V_j$
Total Portfolio Value	$\boldsymbol{V_j}$	

Figure 1: Initial market-adjusted portfolio

This construction creates a portfolio hedged against market movements, with the following expected return and volatility:

$$\frac{dP_j}{P_j} = r_f\, dt + s_j g_j\, de_j \tag{3}$$

where $g_j \equiv \sqrt{\left(1 - r_{jm}^2\right)}$

The standard deviation of this portfolio is $s_j \sqrt{\left(1 - r_{jm}^2\right)}$, the cost of establishing this portfolio is $V_j(t)$ (firm j's stock price), and the expected return on this zero-beta portfolio is the risk-free rate, r_f.

Value of the Market-Adjusted Portfolio at time t=1		
$\bar{r}_j \equiv$ realized return for firm j; $\bar{r}_m \equiv$ realized return of the market		
Asset	**Long Position**	**Short Position**
Stock	$V_j(1+\bar{r}_j)$	
Market		$-b_j V_j\ (1+\bar{r}_m)$
Riskless Asset	$b_j\ V_j(1+r_f)$	
Value of Long or Short Position	$V_j(1+\bar{r}_j)+b_j\ V_j(1+r_f)$	$-b_j V_j\ (1+\bar{r}_m)$
Total Portfolio Value	$\boldsymbol{V_j\left[1+\left(\bar{r}_j - ß_j\left(\bar{r}_m - r_f\right)\right)\right]}$	

Figure 2: The market-adjusted portfolio after one period

As Figure 2 illustrates, the one-period realized return on this portfolio can therefore be expressed as $\bar{r}_j - b_j\left(\bar{r}_m - r_f\right)$, that is, the firm return net of the appropriate market risk premium, where the bar above the returns $\bar{r}_j$ and $\bar{r}_m$ represents the actual return from time 0 through 1.

Does this portfolio hedged against market movements increase in value only if the firm's performance exceeds its market benchmark? Consider our earlier test using the variable exercise approach to designing an indexed option. We found that if the stock price increased by 10% and the market increased by 10% (leading to an exercise increase of 10%), the value of the option would also increase by 10%. Following this example and using the market as a benchmark, we find that under the proposed alternative design the value of the underlying asset (the portfolio hedged against market movements) remains unchanged.[16] Specifically, the long position in the stock increases in value by 10%, and the short position in the market exactly offsets this increase with its own 10% value decrease. Hence, the value of managers' options remains unchanged because the value of the option on this performance-benchmarked portfolio does not change unless the firm's performance exceeds its market benchmark.

B. Designing a Portfolio Hedged against both Industry and Market Movements

The performance-benchmarked portfolio described above removed only the effect of market movements on the firm's stock price. The performance-benchmarked portfolio presented in this section removes the effect of both industry and market returns on firm *j*'s returns, and its value therefore depends solely upon firm *j's* idiosyncratic risk. To implement such a portfolio, one goes long the stock, and short both the market, and the industry "ex-market" (that is, the industry after the market component has been removed). Specifically, the market- and industry-adjusted portfolio has fraction 1 in stock j, fraction b_j short in the market portfolio, fraction $\frac{g_j s_j h_{ji}}{g_i s_i}$ short in the industry (ex-market) portfolio, and $\left[\frac{g_j s_j h_{ji}}{g_i s_i} + b_j\right]$ in the riskless asset, where $g_j \equiv \sqrt{1 - r_{jm}^2}$ and $g_i \equiv \sqrt{1 - r_{im}^2}$.

Equivalently, one can express the portfolio in terms of the unadjusted industry portfolio, rather than the "industry ex-market" portfolio. So, in these terms, the market- and industry-adjusted portfolio contains fraction 1.0 in stock *j*, $b_j \left[1 - \left(\frac{b_i}{b_j}\right)\left(\frac{s_j}{s_i}\right)\sqrt{\frac{1 - r_{jm}^2}{1 - r_{im}^2}}\; h_{ji}\right]$ short in the market, fraction $\frac{g_j s_j h_{ji}}{g_i s_i}$ short in the industry portfolio, and $\left[\frac{g_j s_j h_{ji}}{g_i s_i} + b_j\right]$ in the riskless asset.

Figure 3 displays the market- and industry-adjusted performance-benchmarked portfolio strategy.

[16] To maintain symmetry with the variable exercise option example, the market-adjusted portfolio is structured as if the beta of the stock equals one.

Establishing the Market-and Industry-Adjusted Portfolio at time t=0		
Asset	**Long Position**	**Short Position**
Stock	V_j	
Market		$-b_j V_j$
Industry (ex-market)		$-\frac{g_j s_j h_{ji}}{g_i s_i} V_j$
Riskless Asset	$\left[\frac{g_j s_j h_{ji}}{g_i s_i} + b_j\right] V_j$	
Cost of Long or Short Position	$V_j + \left[\frac{g_j s_j h_{ji}}{g_i s_i} + b_j\right] V_j$	$-b_j V_j - \frac{g_j s_j h_{ji}}{g_i s_i} V_j$
Total Portfolio Value	$\boldsymbol{V_j}$	

Figure 3: Cost of establishing market- and industry-adjusted portfolio

Thus, letting $P_j^*(t)$ represent the value of this "stock j - indexed" portfolio, the expected return and volatility are denoted:

$$\frac{dP_j^*}{P_j^*} = r_f \, dt + s_j' \, dq_j \tag{4}$$

where dq_j is uncorrelated with the industry and the market portfolios and

$$s_j' \equiv \left(g_j d_j \right) \; s_j$$

$$g_j \equiv \sqrt{1 - r_{jm}^2}$$

$$d_j \equiv \sqrt{1 - h_{ji}^2}$$

The standard deviation of this market- and industry-adjusted performance-benchmarked portfolio is therefore:

$$s_j' = s_j \sqrt{\left(1 - r_{jm}^2\right)\left(1 - h_{ji}^2\right)}$$

The cost of establishing the portfolio is $V_j(t)$ (the stock price of firm j) and the expected return is the risk-free rate.

Value of the Market- and Industry-Adjusted Portfolio at time t=1 $\bar{r}_j \equiv$ realized return for firm j $\bar{r}_m \equiv$ realized return of the market $\bar{r}_i \equiv$ realized return on the industry ex-market portfolio		
Asset	**Long Position**	**Short Position**
Stock	$V_j(1+\bar{r}_j)$	
Market		$-b_j V_j\ (1+\bar{r}_m)$
Industry (ex-market)		$-\frac{g_j s_j h_{ji}}{g_i s_i} V_j\ (1+\bar{r}_i)$
Riskless Asset	$\left[\frac{g_j s_j h_{ji}}{g_i s_i} + b_j\right] V_j\,(1+r_f)$	
Value of Long or Short Position	$V_j\ (1+\bar{r}_j) + \left[\frac{g_j s_j h_{ji}}{g_i s_i} + b_j\right] V_j\ (1+r_f)$	$-b_j V_j (1+\bar{r}_m) - \frac{g_j s_j h_{ji}}{g_i s_i} V_j\,(1+\bar{r}_i)$
Total Portfolio Value	$\boldsymbol{V_j\left[1+\left(\bar{r}_j - ß_j\left(\bar{r}_m - r_f\right) - \left(\frac{?_j s_j ?_{ji}}{?_i s_i}\left(\bar{r}_i - r_f\right)\right)\right)\right]}$	

Figure 4: Realized value of the market- and industry-adjusted portfolio after one period

Thus, as illustrated in Figure 4, the one-period realized return on the market- and industry-adjusted portfolio is $\bar{r}_j - b_j\left(\bar{r}_m - r_f\right) - \left(\frac{g_j s_j h_{ji}}{g_i s_i}\left(\bar{r}_i - r_f\right)\right)$, which is the firm return net of the market risk premium and net of the return that is correlated with the industry. One can again confirm that the value of the performance-benchmarked portfolio increases only if the firm's stock price movement exceeds its industry and market benchmarks. The appendix details the derivation of this portfolio.

In sum, “indexed options” as popularly envisioned with a variable exercise price reward managers for performance unrelated to their efforts. Performance-benchmarking the portfolio using the straightforward modifications to the option structure described above *does* have the desired properties of a relative-performance based compensation scheme. These proposed modifications require an option using a market- and/or industry-adjusted performance-benchmarked portfolio as the underlying asset. For the remainder of the paper, I refer to this “indexed portfolio” structure as an “option on a performance-benchmarked portfolio”, or a “performance-benchmarked indexed option,” or simply the “indexed-portfolio option.” Even though the option on the performance-benchmarked portfolio differs in form from an indexed option with a variable exercise price, both structures have the same conceptual goal, that is, to reward relative performance.

III. The Efficiency of Options on the Performance-Benchmarked Portfolio

We have seen that the options on the performance-benchmarked, or indexed, portfolios outlined above have the properties desired by advocates of relative-performance-based options, that is, they reward managers only for increases in the firm’s stock prices that are not explained by industry or market movements. But, one important concern remains. Are these performance-benchmarked indexed options an “efficient” way to pay managers? Put differently, how large is the difference between the firm’s cost to provide the options (the market value of those options), and the private value that managers place on those options? The gap between the firm’s cost of options and the manager’s private value for those options is a deadweight loss to the firm: all other things equal (i.e. the incentive and retention effects produced by the compensation system), the firm should minimize this gap.[17]

[17] The wedge between the firm’s cost and the manager’s private value is widely-recognized in the principal-agent literature. See, for example, Murphy (1998), Carpenter (1998),and Detemple and Sundaresan (1999). Meulbroek (2001a) explores how different types of risk (i.e. systematic versus idiosyncratic) impose different costs on the manager: the manager is “compensated” through market returns for systematic risk, but not compensated for holding idiosyncratic risk. Other factors, beyond the scope of this paper, can contribute to the costs borne by the firm when awarding executive stock options. One example of such a cost is the additional agency costs that may arise when managers alter the firm’s investment profile in non-value creating ways in order to lower their total level of risk. Carpenter (2000) formally models this problem.

While it can certainly be minimized, this gap between firm's cost of equity-based compensation and the private value that managers place on that compensation cannot be eliminated, as it is inherent in any compensation system that seeks to more closely align the interests of managers with shareholders. Properly aligning incentives *requires* that the firm's managers be exposed to firm-specific risks, and this forced concentrated exposure compels managers to hold less-than-fully-diversified investment portfolios.[18] Because undiversified managers are exposed to the firm's total risk, but rewarded (through expected returns) for only the systematic portion of that risk, managers will value stock or option-based compensation at less than its market value. The firm, then, always faces a tradeoff between the benefits attained through incentive alignment and the deadweight cost of paying managers in a currency that is worth less to them than its cost to the firm.[19] The cost is "deadweight" in the sense that firms could issue equity or options in the market, reaping their full value to a diversified investor, but the firm instead issues the equity and options to its managers, who place a lower value on it. The deadweight costs increase with both firm volatility and with the percentage of a manager's personal wealth tied up in the firm.

This cost due to lost diversification cannot be eliminated without destroying incentive alignment, meaning that it is a *structural* cost associated with incentive-based compensation. Individual preferences can also cause managers to value their equity-based compensation at less than its market value. For example, the *level* of overall risk faced (as opposed to its composition) by the manager may be higher or lower than the manager would choose if not compelled to hold the firm's stock or options. If the manager's preferences were known (i.e. the manager's specific utility function and the parameters for that function were known), we could measure this individual preference-based cost

[18] One might even argue that managers' wealth is not fully-diversified even before considering the composition of their securities portfolios as at least some of their human capital may be specific to their employer.

[19] I call this gap between managers' private value and the firm's cost a "deadweight cost" to distinguish it from the market value of the firm's compensation, which is the usual definition of "cost" in the executive compensation literature.

using the “certainty-equivalent” approach adopted in the prior compensation literature.[20] But, identifying individual utility functions is difficult. Moreover, financial engineering has the potential to reduce or eliminate the costs that arise from individual preferences.[21] Therefore the approach adopted in this paper is to focus on the cost generated solely by the manager’s loss in diversification, a cost that is both shared by all managers and cannot be eliminated or reduced either through financial engineering or employee self-selection into jobs with compensation packages best tailored to their preferences.[22]

Meulbroek (2001a) presents a technique to measure the lost diversification cost associated with stock and conventional options. In that paper, I find that the wedge between firm cost and employee benefit of both stock and conventional option awards can be quite large. Undiversified managers of the average NYSE firm, for example, value their (conventional) options at 70% of the cost of these options to the firm. The gap is larger for Internet-based firms, where the value placed on the conventional options by an undiversified manager represents an average of 53% of the cost of these options to the Internet-based firm. The large magnitude of this deadweight cost for conventional options warrants an examination of the deadweight costs of the performance-benchmarked option portfolios described above. The efficiency method developed here for these indexed portfolios follows a methodology similar to Meulbroek (2001a).

[20] For examples of this individual utility-based technique, see Hall and Murphy (2000a), Hall and Murphy (2000b), Huddart (1994), or Lambert et al. (1991). If one wanted to explicitly incorporate costs of lost diversification, the models used in these papers would have to be modified to incorporate more than one risky asset, along the lines of Jin (2000). Even then, using a specific functional form of a manager’s utility function to calculate a certainty-equivalent value conflates the effect of managerial preferences about the functional form of the compensation plan with the effect due to lost diversification. For example, a manager holding a stock perfectly correlated with the market will effectively be fully-diversified. The Sharpe ratio method used in this paper tells us that the efficiency of such equity-based compensation is 100%, that is, the manager will value the perfectly-correlated stock at its full market value. Yet, the utility-function approach tells us that the manager values this stock at less than its market value, simply because the risk exposure created by holding that stock is unlikely to be the optimal risk exposure for that particular manager.

[21] Indeed, indexed options themselves are an example of a financial instrument designed to lower the manager’s total risk exposure while maintaining an equivalent degree of incentive alignment

[22] To measure the *full* cost to managers imposed by any given compensation system, the Sharpe ratio method presented here could be combined with the certainty-equivalent method used in prior research, such as the multi-asset model from Jin (2000), or a modification of the technique used in Carpenter (1998) or Hall and Murphy (2000a).

A. A technique to estimate the loss-of-diversification cost for stock- and option-based compensation indexed for market and/or industry movements

To estimate this loss-of-diversification cost, we calculate the expected return a manager would require in order to be indifferent between holding the market- or market- and industry-adjusted performance-benchmarked portfolios, and holding an efficiently-diversified portfolio levered to a volatility level that equals that of the performance-benchmarked indexed portfolios. Of course, this method produces a lower-bound estimate of the actual cost from the manager's concentrated exposure because it does not account for that manager's individual preferences regarding the level or pattern of risk exposure she faces.[23] The risk-return profile required by a manager to make him or her indifferent between holding the market and holding the performance-benchmarked indexed portfolio is imbedded in the market's Sharpe ratio. Therefore, the performance-benchmarked indexed portfolio's volatility level, along with the market's Sharpe ratio allows one to extract the minimum return an undiversified manager would require in compensation for accepting the diversification constraint. The analysis below shows how to translate this required return premium demanded by the undiversified manager into the private value that such a manager places on the performance-benchmarked indexed stock portfolio that constitutes his or her investment portfolio.

The strength of the Sharpe ratio technique used here is that it measures the common cost imposed on all managers by firm-specific risk, and by so doing isolates the one type of risk that is essential to properly aligning incentives. The Sharpe ratio method, however,

[23] The description of this method as an upper-bound abstracts from the possibility of "re-pricing" the option in an executive's favor (in an effort to re-align managerial incentive levels, firms will sometimes lower the exercise price of out-of-the-money options). The method does, however, explicitly incorporate the notion of a vesting schedule, which is sometimes referred to as feature which reduces the firm's cost of issuing executive stock options. One additional caveat to the "upper bound" characterization: it assumes that the manager has limited opportunity to take risk reduction actions without the help of the firm. Such measures might include limiting their exposure to market risk by shorting S&P 500 futures, thereby offsetting the systematic risk inherent in their positions in company stock. While a theoretical possibility, in practice, few managers appear to engage in such transactions, perhaps because of the liquidity risk induced by this strategy. That is, managers would have to mark-to-market their S&P 500 positions daily, and post additional margin in case of a market increase, but they would not be able to use their holdings in company stock or options to meet the margin call. Managers might also be able to reduce risk through equity swaps (see Bolster et al. (1986)), but changes in the tax code have made such swaps considerably less attractive, or through zero-cost collars, although this appears to be relatively rare (see Bettis et al. (1999)). Schizer

does not incorporate the additional cost associated with individual managers' preference, and therefore our estimate of the manager's private value is likely to be an upper-bound estimate of the value of the specific compensation plan to each individual manager. An exact estimate of the manager's private value of his/her compensation would subtract an additional manager-specific discount to account for the lack of a compensation plan custom-tailored to the manager's.[24]

Our previous assumption that CAPM holds instantaneously in a continuous-time model yields mean-variance behavior.[25] Interpreted in the context of this paper, mean-variance behavior implies that even people with high risk tolerances, such as entrepreneurs, prefer the higher expected return produced by a leveraged fully-diversified portfolio to the lower expected-return from an equally risky less-than-fully-diversified indexed option portfolio.

Additional Notation:

$e^{r_{indexed\ port\ j}}$ $\equiv$ (1 + yearly expected rate-of-return of a performance-benchmarked portfolio of security *j* under CAPM pricing)

$e^{r^{u}_{indexed\ port\ j}}$ $\equiv$ (1 + yearly expected rate of return on the performance-benchmarked indexed portfolio based upon stock *j* required by an *undiversified* mean-variance optimizing investor to make that investor indifferent between holding only the

(2000) notes that hedging of stock option positions can be difficult for managers as many firms prevent executive stock options from being pledged as collateral.

[24] If one wanted to evaluate this *additional* cost of the sub-optimality of the option as the contingent-claim used to create firm-specific exposure, one could use the multi-asset model from Jin (2000), or a modification of the technique used in Carpenter (1998) or Hall and Murphy (2000a).

[25] This assumption is not critical in the sense that the same method presented here could be adapted to incorporate any asset-pricing model (of course, the numerical estimates will change, but the technique will not).

indexed portfolio, and holding a market portfolio with a volatility equal to that of the indexed portfolio)

$s_j \equiv r^{u}_{indexed\,port\,j} - r_f \equiv$ the instantaneous spread between the expected return, required by an undiversified investor holding the performance-benchmarked indexed portfolio consisting of stock j (and short the market or industry), $r^{u}_{indexed\,port\,j}$, relative to the CAPM-based expected return for those indexed portfolios, r_f .

What kind of return would the undiversified investor require as compensation for his/her exposure to the total risk of these performance-benchmarked indexed portfolios? If an undiversified investor had the market portfolio as an alternative investment opportunity, and were a mean-variance efficient investor, he/she would expect an excess return/risk ratio as good as the market's risk-return ratio in order to be indifferent between holding the market portfolio and the performance-benchmarked "stock j" indexed portfolio. To calculate the excess return commensurate with the risk level of this "stock j indexed portfolio", using the market's risk-return ratio as a benchmark, we equate Sharpe ratios and solve for $r^{u}_{indexed\ port\ j}$:

$$\frac{r_m - r_f}{s_m} = \frac{r^{u}_{indexed\ port\ j} - r_f}{s_{indexed\ port\ j}} \quad \Rightarrow \quad r^{u}_{indexed\ port\ j} = r_f + \left[\frac{s_{indexed\ port\ j}}{s_m}\right]\left(r_m - r_f\right) \qquad (5)$$

So s_j, the return premium, must then equal

$$s_j = \left(\left[\frac{s_{indexed\,port\,j}}{s_m}\right]\right)\left(r_m - r_f\right)$$

where $s_{indexed\ port\ j}$ depends upon the type of performance-benchmarked indexing used to form the portfolio.

Specifically,

$$\sigma_{market-adjusted\,port\,j} = \sigma_j \sqrt{\left(1-\rho_{jm}^2\right)}$$

$$\sigma_{market\,and\,industry\,adjusted\,port\,j} = \sigma_j \sqrt{\left(1-\rho_{jm}^2\right)\left(1-\eta_{ji}^2\right)}$$

Figure 5 displays the estimation of the required rate of return graphically.

Compensating the Manager for Total Risk of the Indexed Portfolio

<u>Hold sigma (risk) fixed:</u> What return does manager need to make him/her indifferent between holding the indexed portfolio (with stock j) and holding the market portfolio?

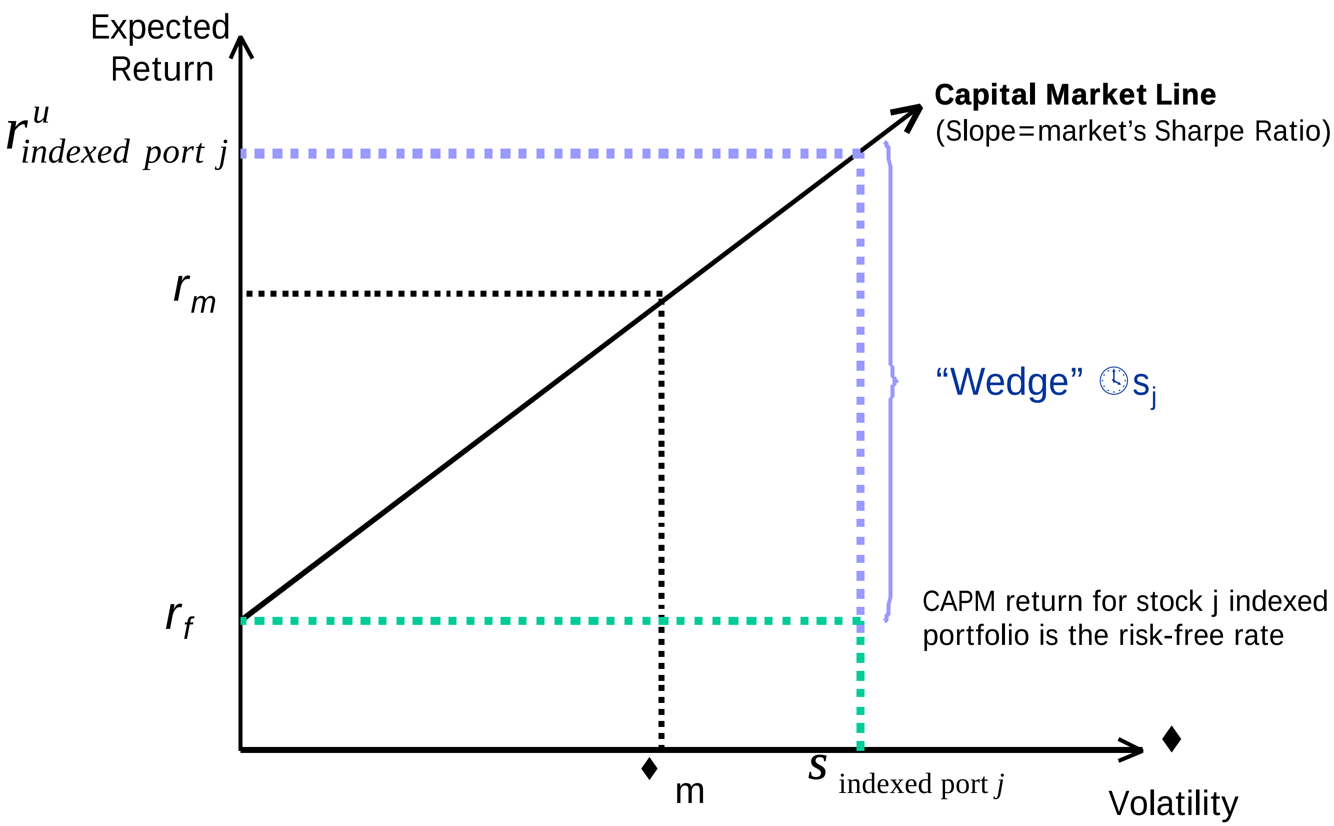


Figure 5: Return Required to Compensate for Manager's Loss of Diversification

To transform this s_j into the value of performance-benchmarked indexed portfolio j to an undiversified investor, we use the following additional notation:

$V_j(t) \equiv$ the value of performance-benchmarked indexed portfolio *j* time *t* (the market price), which equals $P_j(t)$ or $P_j^*(t)$ depending upon whether the portfolio is hedged against the market and/or the industry.

$d_j \equiv$ firm *j*'s proportional payout rate, continuously-paid.

$T \equiv$ date at which the undiversified investor is free to sell the stock (typically the vesting date)

$V_j^u(t) \equiv G(V_j(t), \tau, d_j, s_j)$, the private value placed on the performance-benchmarked indexed portfolio of stock j by investor forced to hold that undiversified portfolio until date *T*, where $\tau \equiv T - t$.

In the analysis below, we assume for analytical simplicity that $d_j = 0$, that is, the firm does not pay dividends for all $t \leq T$.

By definition, we know that the discounted expected future value of the stock *j* indexed portfolio is firm *j* at time *T* equals today's stock price (recall that the performance-benchmarked indexed portfolios are constructed to have betas of zero, so the CAPM required-rate-of-return on these portfolios hedged against the market and/or the industry is the risk-free rate).

$$V_j(t) = e^{-r_f \tau} E_t\{V_j(T)\} \tag{6}$$

where E_t is the conditional expectation of the value of the shares of j at *T*, conditional on the information available at time *t*. And similarly, by definition of $r^u_{indexed\,port\,j}$, we know that the expected future value of the performance-benchmarked indexed portfolio to the undiversified investor discounted by $r^u_{indexed\,port\,j}$ is the value of the firm today to that investor.

$$V_j^u(t) = e^{r^u_{indexed\,port\,j}} E_t\{V_j^u(T)\} \tag{7}$$

But, at date T, the undiversified investor is free to sell his/her shares in the open market, so therefore, at date T for every outcome, the value of the stock to the undiversified investor will equal the market value of the firm:

$$V_j^u(T) \;=\; V_j(T)$$

and hence this statement must hold expectationally as well:

$$E_t\left\{V_j^u(T)\right\} \;=\; E_t\left\{V_j(T)\right\} \qquad (8)$$

Substituting (8) into (6) and (7), we have

$$\begin{aligned} V_j^u(t) &= e^{r^u_{indexed\,port\,j}} E_t\left\{V_j(T)\right\} \\ &= e^{r^u_{indexed\,port\,j}} \cdot e^{-r_f t} \cdot V_j(t) \qquad (9) \\ &= e^{-s_j t} V_j(t) \end{aligned}$$

$$\Rightarrow e_{indexed\ port\ j} \;=\; \frac{V_j^u(t)}{V_j(t)} \;=\; e^{-s_j t} \qquad (10)$$

The “efficiency” of stock j indexed performance-benchmarked portfolio compensation to an undiversified investor, $e_{indexed\ port\ j}$, is the ratio of the performance-benchmarked indexed portfolio’s value to an undiversified employee relative to the cost of that compensation to the firm, V_j. See Figure 6.

To sum up, the explicit expressions for the efficiency of the performance-benchmarked indexed portfolios are:

$$e_{market-adjusted\ port\ j} \;=\; e^{-\left[\frac{s_j}{s_m}\right]\sqrt{\left(1-r_{jm}^2\right)}\left[r_m - r_f\right]t}$$

$$e_{market-and\,industry-adjusted\ port\ j} \;=\; e^{-\left[\frac{s_j}{s_m}\right]\sqrt{\left(1-r_{jm}^2\right)\left(1-h_{ji}^2\right)}\left[r_m - r_f\right]t}$$

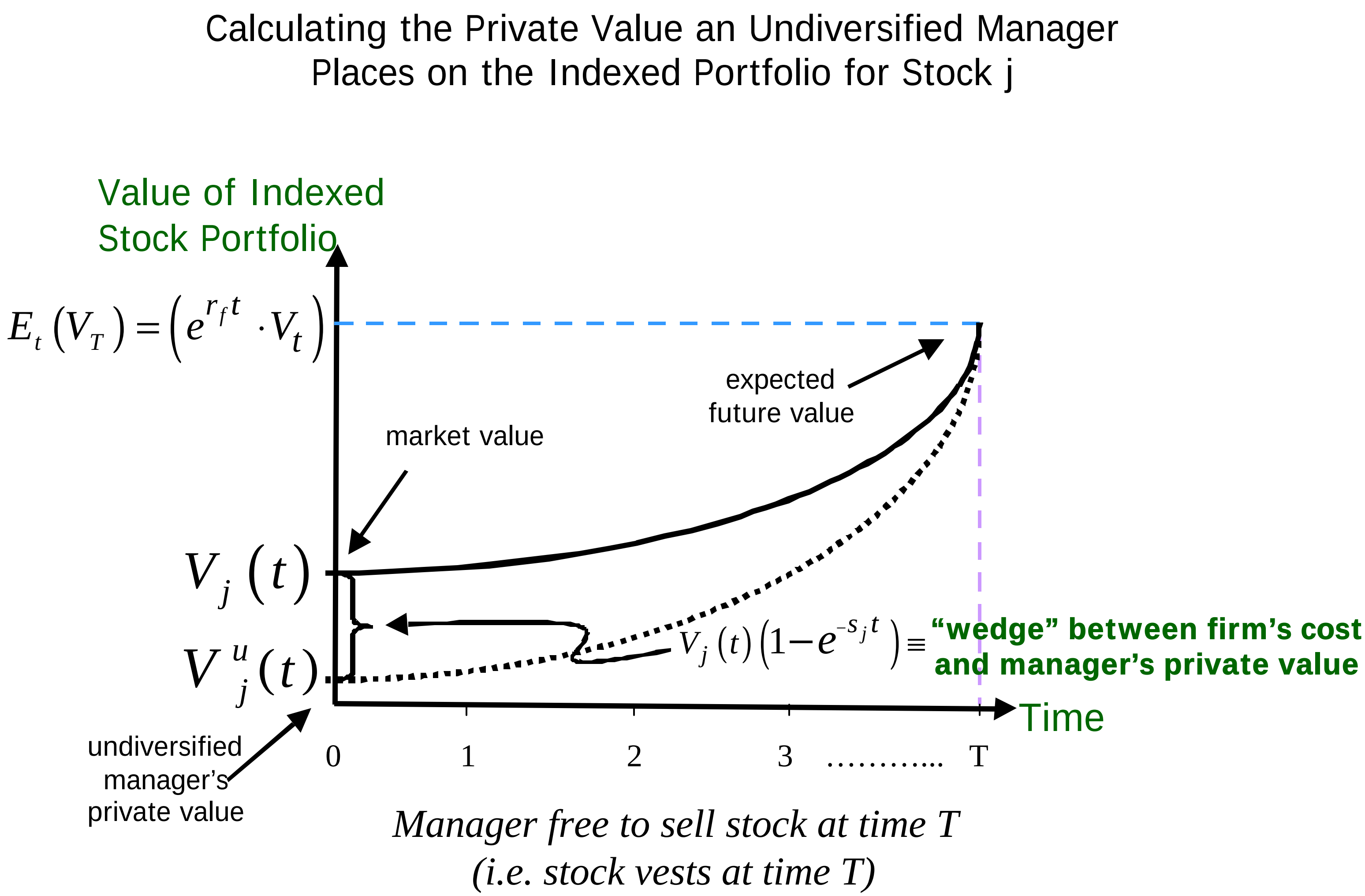


Figure 6: The Manager's Private Value for the Indexed Portfolio

Equation (10) shows that the return premium required by the undiversified investor, s_j, is a function of r_{jm}, h_{ji}, s_j, and t (time period over which the stock vests), as well as s_m and the market expected return. The return premium s_j is biggest (i.e. the efficiency is the lowest) when s_j is large relative to s_m, and when r_{jm} and h_{ji} are low.

The derivation of the lack-of-diversification discount for the *option* on the performance-benchmarked indexed portfolio parallels that of the lack-of-diversification discount for the performance-benchmarked indexed portfolio, presented above, but is more complex because both the expected return and the standard deviation of the option on the indexed portfolio change at every point in time. To find the lack-of-diversification discount for the performance-benchmarked indexed option, we assume that the employee will be indifferent between concentrated-versus-efficiently-diversified exposures if he or she is presented with the same (instantaneous) Sharpe ratio in either case (just as we did for the derivation for the discount on the indexed portfolio). More specifically, we equate the instantaneous Sharpe ratio of the market to the instantaneous Sharpe ratio of the option to solve for the instantaneous expected return required to compensate the undiversified manager. The formal derivation, found in Meulbroek (2001a), shows that the pricing of an option that at every point in time provides an instantaneous Sharpe-ratio equal to the instantaneous Sharpe ratio on the market portfolio is exactly the Black-Scholes-Merton option-pricing formula on a non-dividend paying stock where we replace the market price of the performance-benchmarked indexed portfolio, V_j, by its discounted private value, V_j^u, as indicated below, where Φ represents the efficiency of the option and $f(\bullet)$ represents the Black-Scholes-Merton option-pricing formula. Applying this technique to indexed options yields:

$$\Phi \equiv Efficiency\ \ of\ \ Option\ \ Compensation = \frac{f\,(V_j^u, T-t, s_{\ indexedportfolioj}, r_f,\ X = V_j)}{f\,(V_j, T-t, s_{\ indexedportfolioj}, r_f,\ X = V_j)} \qquad (11)$$

This method again produces a lower-bound on the undiversified investor’s discount. This lower-bound results from the willingness of some employees to give up an additional amount in expected return terms to change their total level of risk or to pursue a dynamic risk strategy that differs from that of an option.

Note that the efficiency of an option (Φ) will always be less than the efficiency of the underlying stock (e) as

$$\Phi = \frac{F\,(V_j^u, X)}{F\,(V_j\,, X)} < \frac{e^{-st}\,F\,(V_j\,, X)}{F\,(V_j\,, X)} = e^{-st} \;= e$$

The dynamics of option efficiency, however, are similar to those for stock efficiency. As the expected rate of return premium increases, option efficiency decreases, and as vesting periods increase, option efficiency decreases. Changes in the required expected rate of return premium have a larger effect on the option efficiency than do changes in the vesting period. And, as the time until option maturity increases, efficiency increases, but only slightly.

B. The loss-of-diversification cost of market- and industry-adjusted performance-benchmarked portfolio options versus conventional options

The overall volatility of the performance-benchmarked indexed portfolios will be less than the volatility of the firm's equity alone, because the indexed portfolios remove either market volatility or market and industry volatility. Therefore, the manager compensated with performance-benchmarked indexed stock or options bears *less* total risk than a manager compensated with the firm's stock or conventional options. Yet somewhat surprisingly, the loss-of-diversification cost for indexed options need *not* be less than the loss-of-diversification cost associated with conventional options. To see this, note that the premium required to compensate an undiversified investor for holding the firm j's stock (s_j) is:[26]

$$s_j = \left(1 - r_{j,m}\right)\left[s_j\right]\left[\frac{r_m - r_f}{s_m}\right]$$

[26] See Meulbroek (2001a).

and the premium required to compensate an undiversified investor for holding a portfolio of firm j's stock indexed to the market, ($s_j^{market-adjusted}$), is:

$$s_j^{market-adjusted} = \sqrt{1 - r_{j,m}^2}\left[s_j\right]\left[\frac{r_m - r_f}{s_m}\right]$$

and the premium required to compensate an undiversified investor for holding a portfolio of firm j's stock indexed to both the market and industry ($s_j^{marketandindustryadjusted}$), is:

$$s_j^{marketandindustryadjusted} = \sqrt{\left(1 - r_{jm}^2\right)\left(1 - h_{ji}^2\right)}\left[s_j\right]\left[\frac{r_m - r_f}{s_m}\right]$$

If the correlation between the firm returns and the market returns is positive ($0 < r_{jm} < 1$), then

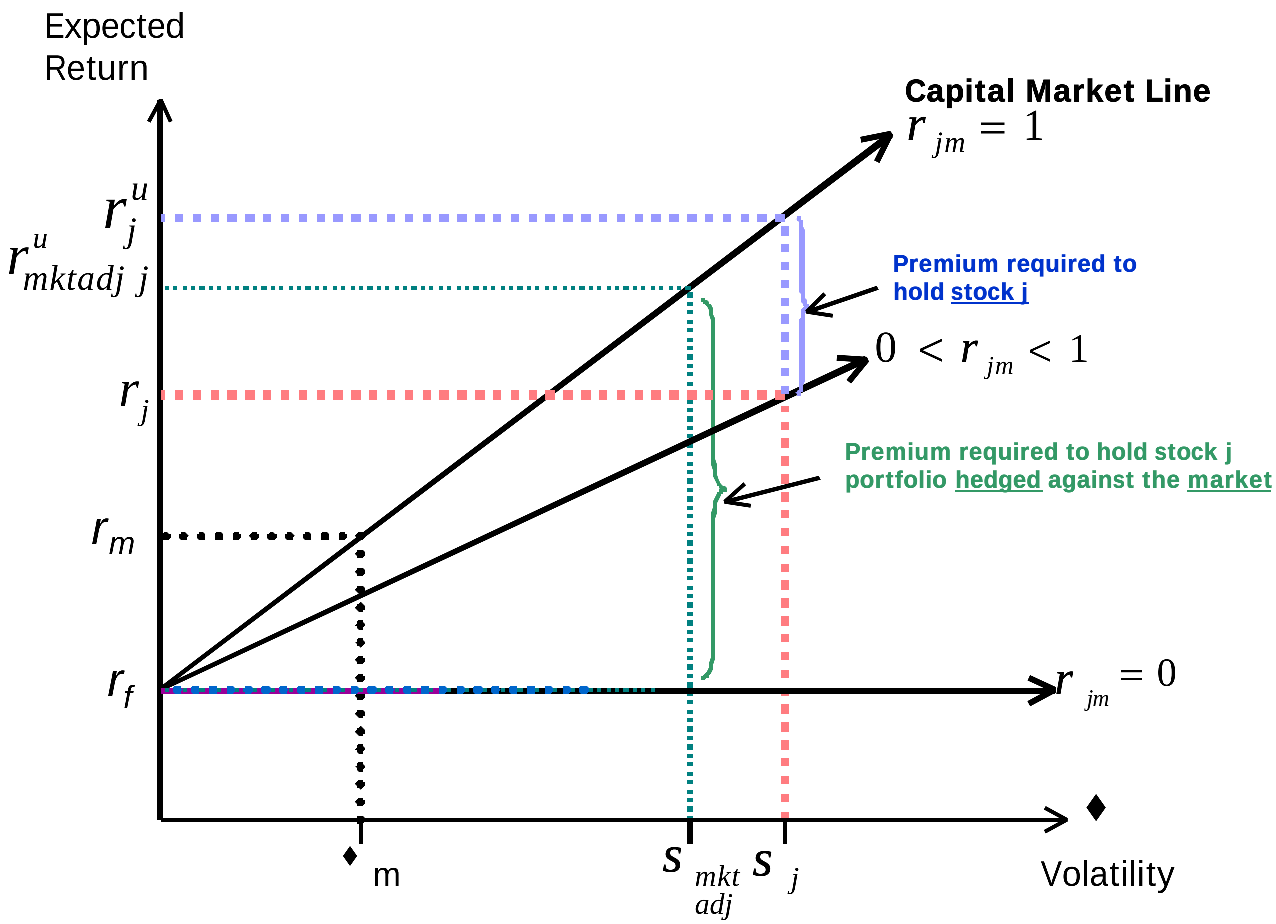
$$\sqrt{1 - r_{j,m}^2} > \left(1 - r_{j,m}\right) \Rightarrow s_j^{market-adjusted} > s_j$$

and

$$\sqrt{\left(1 - r_{jm}^2\right)\left(1 - h_{ji}^2\right)} > \left(1 - r_{j,m}\right) \Rightarrow s_j^{marketandindustryadjusted} > s_j$$

The intuition behind this result is that the loss-in-diversification cost arises from the amount of non-diversifiable (firm-specific) risk that the manager is required to hold. Because the market-adjusted portfolio removes (by definition) the systematic risk associated with the firm's stock, the only type of risk that remains is the firm-specific risk, which is exactly the type of risk that is costly for the manager to bear. Moreover, the expected return from the market-adjusted portfolio is the risk-free rate. Figure 7 illustrates this process.

Figure 7: The Cost of Lost Diversification with Indexed Portfolio (Hedged Against Market)

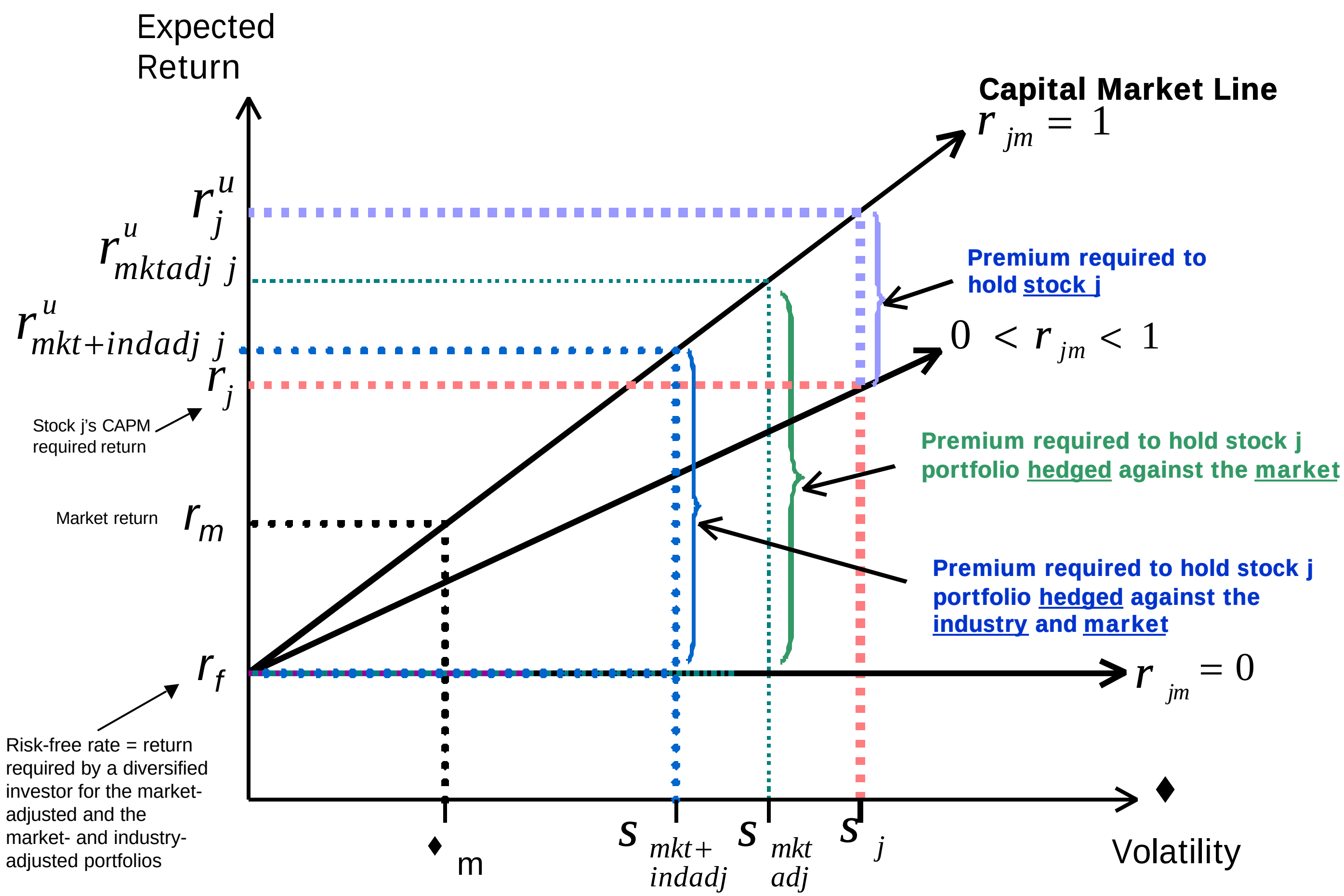


So, as long as the correlation between firm returns and market returns is positive (as one would generally expect), the efficiency of a performance-benchmarked, or indexed, option is less than the efficiency of a conventional option. In other words, managers will place a higher discount from market value for performance-benchmarked options than they would for conventional options. While this gap between managers private value and the market value is larger for performance-benchmarked options, it may *still* be optimal for the firm to compensate managers with such options. After all, the cost estimates derived above do not reflect the benefits associated with equity-based compensation. And of course, one important benefit associated with equity-based compensation is incentive alignment. Because performance-benchmarked portfolio options expose the manager to a "purer" risk, that is, a risk over which the manager has control, they may indeed generate greater incentive alignment benefits. But, the costs derived above do suggest that the incentive alignment benefits of performance-benchmarked portfolio options must be higher than those associated with conventional options, or their use is not justified.

C. The additional benefit created by removing industry effects from equity-based compensation

The analysis above shows how the removal of systematic risk from the manager's equity-based compensation has the somewhat unsettling effect of decreasing compensation efficiency. The same is *not* true when the marginal influence of industry risk is removed. That is, by ridding the manager's portfolio of industry ex-market effects, the firm can unambiguously increase efficiency relative to the market-adjusted portfolio. To see this, consider that the market-adjusted portfolio has no systematic risk, and therefore has a market equilibrium expected return of the risk-free rate. Removing the marginal effect of industry movements from the market-adjusted portfolio reduces the volatility of the portfolio without reducing its expected return, which remains at the risk-free rate (assuming, once again, that the correlation between the firm returns and the market returns is positive ($0 < r_{jm} < 1$). Figure 8 illustrates this concept.

Figure 8: The Cost of Lost Diversification with Indexed Portfolios (Hedged Against Market and Industry)



D. The loss-of-diversification cost of indexed options for the <u>*partially*</u>*-diversified manager*

Of course, the efficiency measures outlined above assume that the manager is compelled to hold *all* of her wealth in equity or options of the firm and is therefore completely undiversified. In reality, managers may hold some (or indeed most) of their wealth outside of the company. How does this ability of the manager to partially-diversify affect efficiency levels? Under partial diversification, the volatility faced by the manager will be a mix of the indexed portfolio's volatility and the volatility of the manager's other holdings. Applying the efficiency metric for a partially-diversified investor from Meulbroek (2001a) to the case at hand shows that an investor having weight *w* invested in the stock j indexed portfolio and (1-*w*) in the market portfolio, where σ_p equals the standard deviation of the combined market plus stock j indexed portfolio,

$$s_p = \sqrt{w^2 s^2_{indexedportfolio} + (1-w)^2 s^2_m + 2w(1-w)s_{indexedportfolio,\,m}}$$

$$= s_m \sqrt{w^2\left(\frac{s_{indexed\ portfolio}}{s_m}\right)^2 + (1-w)^2}$$

The stock efficiency under partial diversification, e^*, is:

$$e^* = \frac{V_j^*(t)}{V_j(t)} = e^{-\left(r_j^* - r_j\right)t} \quad , \text{ where } r_j^* - r_j = \left[\frac{1}{w}\left[\frac{s_p - s_m}{s_m}\right]\right] \ \left(r_m - r_f\right)$$

with the corresponding option efficiency paralleling the earlier derivation. Figure 9 displays the efficiency levels for a hypothetical firm with a volatility and market correlation equal to the average of all Value Line firms, specifically illustrating the efficiencies of a market-adjusted indexed portfolio and an option on that portfolio for managers with various degrees of portfolio diversification. The calculations use a three-year vesting period, meaning that the manager will be free to sell the stock or option in three years.[27] We can see that the ability to partially diversify improves efficiency. For example, the efficiency of a market-adjusted equity portfolio for this hypothetical firm is

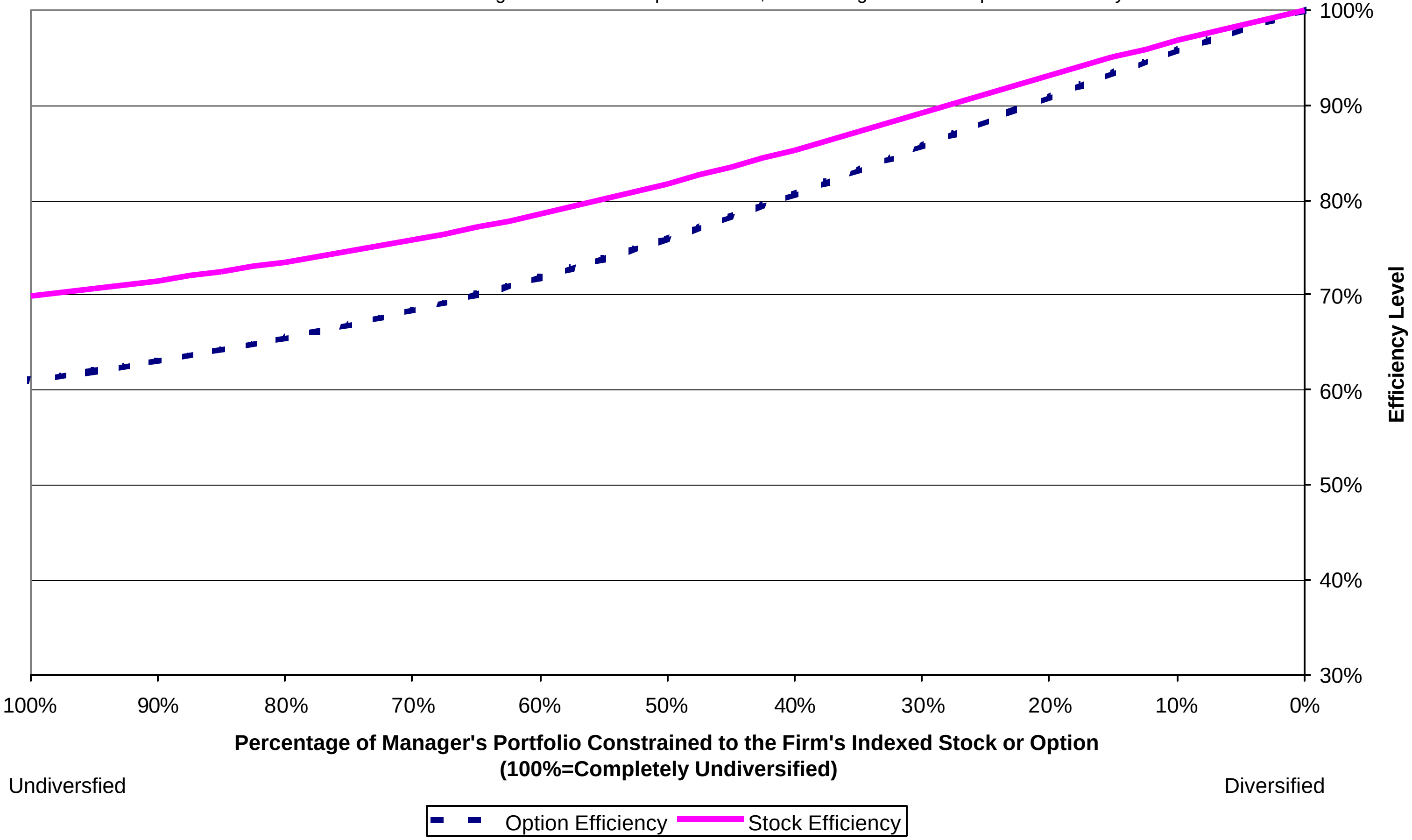
70% for a manager who has no wealth outside the firm, increasing to 82% for a manager with 50% of her wealth outside the firm. The efficiency of the market-adjusted indexed option is 61% for a completely undiversifed manager, improving to 76% for a manager with 50% of her wealth outside the firm.

In Section IV, below, we will apply the technique developed here for estimating the efficiency of options on the performance-benchmarked portfolios in a somewhat different context. In that section we will estimate the combined efficiency of an option on the performance-benchmarked portfolio supplemented by a cash grant. The cash grant is a supplement with a magnitude equal to the difference between the market value of a conventional option to the market value of the option on the performance-benchmarked portfolio.

[27] Specifically, the 1998 year-end volatility averages 52% for Value Line firms, the market volatility is 27%, and the average firm-market correlation is 48%. As a consequence, the average volatility of a market-indexed portfolio is 45%.

Figure 9: Sensitivity of Indexed (Market-Adjusted) Equity-Based Compensation Efficiency to Managerial Portfolio Diversification for Hypothetical Firm

Calculations assume volatility level equal to Value Line firm average, market is the CRSP Value-Weighted Market Composite Index, and manager free to sellportfolio after 3 years



E. Implications for structuring indexed portfolio option compensation plans

Indexed options, that is, options on performance-benchmarked portfolios, will, of course, have a lower market value than conventional options, simply because they have a lower overall volatility level. As a consequence, many proponents of indexed options have suggested that the number of options granted to a manager will therefore have to be adjusted upwards if an indexed option compensation plan is adopted, in order to equate the manager's pay under each system.[28] While this argument is intuitively appealing, our analysis above suggests that a better structure exists. Instead of equating compensation levels across the two types of plans by issuing *additional* options on the indexed portfolios, a more efficient structure is to supplement the indexed portfolio option grant with a "market-value-equivalent" amount of cash compensation, that is, the amount required to bring the manager's total compensation level up to the market value of a conventional option. Cash is perfectly efficient: it leaves the manager free to invest in the market portfolio (or anything else). The market-value-equivalent cash supplement therefore increases the efficiency of the option on the indexed portfolio because it allows the manager to diversify her holdings a bit, boosting efficiency. As a consequence, the cash supplement plus indexed portfolio option package strictly dominates, in an efficiency sense, the policy of boosting the number of indexed portfolio options to equate the market value of the indexed portfolio options with that of a conventional option

Indeed, the firm may want to increase the proportion of cash even beyond the market-value-equivalent level needed to equate the value of the indexed portfolio option (plus cash) with the value of a conventional option. In any compensation plan, the firm is forced to balance the incentive alignment benefits of equity-linked compensation with the loss-of-diversification costs associated with that compensation. An indexed portfolio option plan allows the firm to shift that balance towards cash without sacrificing incentive-alignment. To see this, assume for the moment that the firm has currently found the optimal balance between awarding conventional options and other, non-equity based

[28] After all, the goal of an indexed option compensation is to create better incentive alignment, restoring the link between pay and performance by rewarding managers only for that portion of performance under managers' control. If sole goal were to decrease managers' compensation, firms could simply decrease the

compensation. Performance-benchmarked portfolio options (indexed portfolio options) are designed to limit managers' risk exposures to those the managers can control. If we think that this selected exposure provides better incentive-alignment than the conventional option, then the number of indexed portfolio options can actually be *reduced* relative to the firm's current conventional option grants. With the superior incentive-alignment attributed to indexed portfolio options, the firm could afford to shift its cash-option mix more towards cash. The gains from this strategy, if any, will depend upon the relative efficiency of indexed portfolio options and conventional options, explored in the next section.

IV. An Empirical Analysis of Conventional and Indexed Portfolio Option Efficiency

To better understand how economically significant the efficiency loss created by performance-benchmarking (indexing) is, we investigate the efficiency of indexed portfolio and conventional options (both with and without the cash supplement described above). This analysis should provide some guidance on how to best implement a relative-performance-based compensation plan

Our empirical investigation begins by calculating stock and option efficiency metrics for all firms listed in Value Line's *Investment Survey* as of December 31, 1998. We also examine separately the results for a sample of Internet-based firms defined by the Hambrecht & Quist (H&Q) *Internet Index*.[29] The H&Q *Internet Index* is used because Value Line's coverage of internet-based firms is limited to six firms during the period over which we conduct our examination. Internet-based firms are perhaps of particular interest because much of managers' compensation in these firms is equity-based, and such managers are likely to have a substantial fraction of their wealth invested in these companies. As a consequence, compensation plans that reduce volatility, such as the indexed portfolio plans discussed here, might be especially valuable to these managers.

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number of conventional options granted to managers, rather than go through the trouble of switching to an indexed option system.

[29] The H&Q *Internet Index* comprises a sub-sample of Internet-based firms, and is not confined to H&Q clients. The *Internet Index* is widely-cited and viewed as a reliable reflection of Internet-based activity.

Value Line's industry classifications are widely-held to be more accurate than industries formed using SIC codes. The database of firms and their industry classifications used in this paper are described in Stafford (2001); we have updated that database through year-end 1998.[30] The Stafford-Andrade Value Line data lists all firms and industry assignments collected from fourth quarter editions of Value Line, excluding foreign industries (e.g. "Japanese Diversified" or "Canadian Energy"), ADR's, REIT's, investment funds, and firms with industry classifications of "unassigned" or "recent additions" that are not subsequently assigned to an industry by Value Line. The database uses Value Line's industry classifications, with a few exceptions. For example, industries that differ merely by geographic classifications (e.g., "Utilities (East)" and "Utilities (West)") are merged into one classification; industries where the product lines seem particularly similar (e.g., "Auto Parts (OEM)" and "Auto Parts (Replacement)") are also combined into one category. In total, our sample consists of 1496 Value Line firms classified into 56 industries.

To calculate efficiency levels, we need estimates of β and σ for each firm as inputs. To estimate a firm's β, we use the market model, incorporating the last 150 trading days of returns data prior to December 31, 1998, and using CRSP's value-weighted market composite index. We use these same 150 trading days of returns data to estimate each individual firm's volatility, σ_j, as well as the market's volatility, σ_m, calculated from CRSP's value-weighted market composite index. [31] We assume a risk-premium of 7.5% (7.2% continuously-compounded), the historical average amount by which the value-weighted market index exceeds the long-term government bond rate (beginning in 1926). Continuously-compounded daily excess returns (net of daily riskless rates) are used in all calculations. The Value Line industry components over the six month period ending December 31, 1998 are used to create both value-weighted and equal-weighted daily industry returns.

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[30] The author thanks Gregor Andrade and Erik Stafford for use of this database.

Table 1 displays the characteristics of firms in our sample. Panel A shows that the mean beta for Value Line firms is 0.90, with an annual volatility level of 52%, and the mean firm size (market equity value) is $7.5 billion. Panel B shows that the mean beta and volatility for H&Q Internet based firms is higher than the average Value Line firm (beta = 2.00 and annual volatility = 117%). As a consequence, for a three-year vesting period, the mean efficiency of stock compensation for Value Line firms is 81% (higher than the 63% of H&Q firms), and the efficiency of conventional stock options is 76% (versus 61% for H&Q firms). Table 2 further details some of the information from Table 1 by showing the industry-level figures corresponding to Table 1's summary statistics. We can see from Table 2 that industry-level volatility (volatility calculated using the return of the Value Line industry index) ranges from a low of 16% for the Utility industry, to a high of 57% for Oil Field Services and Equipment,[32] and averaging 32% across all industries. Notice too that the correlation between firm returns and market returns averages 0.48 over all Value Line firms, with a maximum value of 0.70 firm Bank and Thrifts, and a minimum of 0.31 for Utilities.

The correlations give us a preliminary sense of how effective performance-benchmarking (indexing) to the market and or industry might be. The square of the correlation numbers is the R^2 from the CAPM regression model, which indicates how much of the firm's volatility is explained by market movements. From Table 2, the mean R^2 across industries is 23% (the mean R^2 across individual firms is also 23%). The majority of volatility in returns is therefore non-systematic. Similarly, one can look to the last column of Table 2 to see how industry-level indexing might affect volatility. This column displays the correlation coefficient between the firm ex-market returns and the ex-market industry returns. These correlation coefficients calculations remove the effect of market movements, and show us how much correlation remains between the firm and its industry after such an adjustment. The larger the correlation coefficient, the greater the marginal decrease in volatility that can be achieved from removing industry effects from the

[31] In cases where 150 days of data are not available, we require a minimum of 64 observations (3 months) of daily returns for volatility estimation.
[32] Value Lines inchoate Internet industry index has a higher volatility of 79%, but Value Line includes only six firms in this industry, prompting our use of the H&Q Internet Index.

manager's portfolio. Table 2 illustrates that the average firm returns have a correlation of 0.28 with its industry, meaning that the R^2 from a regression of ex-market firm returns and ex-market industry returns is 0.08. Therefore, 8% of the volatility remaining after stripping out market effects from firm returns is due to industry movements. Together, these numbers suggest that much of a stock's volatility is not industry or market related, meaning that the manager will still bear significant firm-specific risk even if options are performance-benchmarked, that is, indexed.

Table 3 turns to the efficiency of stock and option compensation using the indexed portfolios outlined above – a portfolio hedged against market movements, a portfolio hedged against industry movements, and a portfolio hedged against both industry and market movements. Hedging out market movements drops the manager's stock portfolio from a 52% annual volatility to 45% annual volatility. Taking out non-market industry effects drops the volatility to 42%. The column labeled "Efficiency of Stock or Indexed Portfolio) displays the efficiency that results from the combined volatility decrease and shift in the composition (systematic versus idiosyncratic) of that volatility. The efficiency of a stock-based portfolio drops from the 81% associated with a grant of the firm's stock, to 72% for the market- and industry-adjusted stock portfolio. In other words, the private value that a manager places on her stock compensation is 81% of its market value when the firm's stock is used. When the manager is compensated using the market- and industry-adjusted portfolio, the private value that a manager places on that portfolio is 72% of its market value. The drop is somewhat greater for option-based compensation, which moves from an efficiency level of 76% for a conventional option, versus 63% for an option on a market- and industry-adjusted portfolio.

If we stopped the analysis here, the conventional option, with its higher efficiency level, would seem to dominate the indexed portfolio option. Of course, this conclusion ignores several advantages of indexed portfolio options not considered in the efficiency-based cost calculations. First, the indexed portfolio option may better motivate the manager simply because more of the volatility of her stock and option holdings is now under her control. Second, an indexed portfolio option costs less (meaning it has a lower market value) than a conventional option. This means that a firm could supplement its indexed portfolio option grant with a cash grant, in order to bring the combined value of the indexed portfolio option and the cash up to the level of a conventional option. Because cash is 100% efficient from the manager's standpoint (i.e. she can invest cash as she sees fit), this combination will have a higher efficiency than that of the indexed portfolio option alone. Indeed, it is conceivable that this extra cash could boost the efficiency of the indexed portfolio option-cash combination higher than the efficiency level of the conventional option.

To better understand the efficiency of this market-value-equivalent portfolio of indexed portfolio option plus cash, one first needs to know how large the cash grant will be. Of course, the larger the cash grant, the larger the efficiency gains. The last column in Table 3 shows how large a cash grant is needed to equate compensation value across the two different types of option programs: conventional and performance-benchmarked (indexed) portfolio. The mean ratio of the market-indexed portfolio option market value to the market value of the conventional option is 93%, and the mean ratio of the market- and industry-adjusted option is 91%. Thus, the firm gives the manager cash equivalent to 7% of the conventional option's value, combined with an option on a market-adjusted portfolio, or cash equivalent to 9% of the conventional option's value, combined with an option on a market- and industry-adjusted portfolio, to form the market-value-equivalent portfolios.

Table 4 displays efficiency levels for conventional and indexed portfolio options (similar to those in Table 3), but on an industry-by-industry basis. The table reveals that industries such as Utilities, Natural Gas, Bank and Thrifts have efficiency levels for market-adjusted options on the high end of the spectrum, while Internet-based firms, Educational Services, Medical Services and Oilfield Services and Equipment have efficiencies on the lower end. Examining the efficiency levels of the market- and industry-adjusted option portfolio yields much the same story. The market- and industry-adjusted indexed option could be supplemented by an amount of cash ranging from 6% of the conventional option for H&Q Internet-based firms, to 29% of the conventional option's value (Coal and

Alternate Energy), averaging 11% across all industries. So, even after considering the marginal contribution of industry indexing, the majority of the value from the market-value-equivalent market- and industry-adjusted option plus cash package comes from the indexed portfolio option, not from cash.

Is the relatively small cash grant in the market-value-equivalent indexed portfolio option combination enough to boost its efficiency level above that of the conventional option? Table 5 addresses this question. It displays the efficiency level of conventional options, the efficiency level of the indexed portfolio option, and, using the market value ratios from Table 4, the efficiency level the indexed portfolio option plus cash grant. In Table 5, Panel A, can see that the efficiency level of the conventional option for Value Line firms averages 76% versus 63% for the market- and industry-indexed option, before considering the added cash. Mixing in cash averaging 9% of the conventional option's value boosts the efficiency of the indexed portfolio option itself to 65%, and the indexed portfolio option plus cash combination to 68%. The numbers for the other indexed portfolios (market-adjusted or industry-adjusted) are similar. The conclusions for the set of Internet-based firms parallel those of the Value Line firms: the conventional option efficiency has a mean value of 59%, and the market- and industry-adjusted indexed option efficiency moves from its value of 43% to an efficiency level of 48% when the cash supplement is added. Even with the addition of cash, market and/or industry indexing is less efficient (managers place a lower private value on it relative to its market value) than conventional option grants. Note that these efficiency levels would be lower still if the value difference between an indexed portfolio option and a conventional option were paid to the manager in the form of *more* indexed options, rather than in cash (i.e. that 9% value difference would consist of indexed portfolio options, not cash), as advised by many of the proponents of indexed options.

V. Conclusions

Recent market volatility has strengthened the call for indexed options, that is, options whose payoff is linked to some sort of market or industry-based index. Such options hold the potential to propitiate critics of conventional stock options, critics who view the Brobdingnagian fortunes amassed by many managers during the bull-market as the result of luck, not ability or effort. Indexed options compensation, assert its proponents, tightens the link between managerial efforts and compensation by removing overall stock market gains (or losses), or perhaps industry-level gains (or losses) from managers' compensation. While managers have seemed reluctant to adopt compensation indexed to market or industry benchmarks (only one U.S. firm, Level 3 Communications, currently has an indexed option plan), the newly-discovered ability of the market to decrease as well as increase may draw more managerial support for indexing in the future.

In this paper, I examine how an indexed option plan should be structured, and gauge the costs associated with such plans. I show that that when an indexed option plan has a variable exercise price, a structure typically suggested by its advocates, its value *still* reflects market and industry movements. To remedy this unintended outcome, I propose an alternative option structure that has as its underlying asset uses a zero-beta *portfolio* hedged against those price movements, such as market or industry movements, thought to be outside of managers' control. I then show that this "performance-benchmarked portfolio" performs as intended, effectively removing the effects of market or industry performance from the value of the option.

I also compare the deadweight costs of the proposed performance-benchmarked (or indexed) portfolio option plan to the costs of conventional stock options. Deadweight costs arise in any equity-linked compensation plan: equity-linked compensation exposes managers to firm-specific risk, inevitably creating some loss in the managers' ability to hold diversified portfolios. Constrained in their ability to diversify, managers are exposed to the firm's total volatility, rather than the smaller systematic portion faced by the well-diversified investor. As a consequence, the stock's expected returns are too low to fully compensate managers for the risk they must bear, leading them to value their stock and options at less than their market value. This gap between the cost of equity-linked compensation to the firm (its market value) and the value placed on that compensation to undiversified managers, is a deadweight cost to the firm. To determine the optimal proportion of equity-based compensation, the firm must balance the deadweight loss-of-diversification costs against the incentive-alignment benefits produced by that compensation.

Perhaps surprisingly, the deadweight cost of an option on a performance-benchmarked portfolio is *greater* than the deadweight cost of a conventional option. When the option on the performance-benchmarked portfolio factors out the effect of systematic risk, it eliminates the very type of risk that provides the holder of a conventional option with a type of "implicit" diversification. A manager holding a conventional option will bear both systematic and non-systematic risk, and will be compensated through the stock's expected return for the systematic portion of that risk. A manager holding an option on a performance-benchmarked portfolio bears "only" non-systematic risk, and is therefore not "compensated" for any of that risk exposure, leaving the manager with an expected return of risk-free rate on the underlying asset.

To explore whether the theoretical deadweight costs of options on performance-benchmarked portfolios are economically significant, I use a method developed in this paper to empirically estimate their magnitude. I find that the firms tracked by Valu Line have a mean efficiency level of 72% for the conventional stock option, meaning that an undiversified Value Line manager values that option at 72% of its market value on average. Indexing to the market and industry reduces the manager's private value of that option from 72% of market value to 63%. If this indexed (performance-benchmarked) plan is supplemented by a market-value-equivalent cash grant (i.e. the amount necessary so that together the cash plus the indexed option has a market value equal to that of a conventional option), the efficiency level increases to 68%, a level that is still twelve percent lower than the efficiency of the conventional option. And for more volatile Internet-based firms, the contrast is even more striking: the efficiency of a conventional option is 59%, and that of the market- and industry-adjusted indexed plan (supplemented by cash) is 48%, an average twenty-four percent lower than the conventional option.

This deadweight cost analysis has three practical implications, all essential to a firm adopting an indexed option plan. The first is that removing industry-level volatility unambiguously "increases" efficiency of the market-indexed portfolio. This efficiency increase occurs because the market-indexed portfolio is free of systematic risk (by construction), and the marginal effect of removing ex-market industry movements ("ex-market" means the portion industry return unrelated to market movements) from the market-indexed portfolio decreases idiosyncratic volatility without further sacrifice of expected returns. The better the match between the firm's benchmark portfolio and the factors under the managers' control, the more that the manager's exposure to unproductive (and costly) idiosyncratic volatility will decrease.

The second practical implication of the greater deadweight costs associated with a compensation plan structured around options on performance-benchmarked portfolios is that firms implementing the performance-benchmarked portfolios plan should award *fewer* indexed portfolio options than the number that they would have otherwise awarded in a conventional option plan. This practice contradicts the traditional recommendation that managers receiving performance-benchmarked options be granted a *greater* number of options than they would otherwise receive under a conventional option plan. Increasing the number of options on a performance-benchmarked portfolio, however, would only exacerbate the deadweight cost problem. Instead, to increase efficiency while bringing the value of the option on the performance-benchmarked portfolio grant up to the value of the conventional option, the firm can supplement the option on the performance-benchmarked portfolio with enough cash to equate the dollar value of the two types of option plans. The efficiency level of this market-market-value-equivalent indexed option portfolio is greater than the efficiency of the performance-benchmarked option alone. Nevertheless, as an empirical matter, the cash required to equate the two market values is too small to alter efficiency much. That is, at least for Value Line firms, the combined efficiency of the market-market-value-equivalent indexed option plan is *still* less that the efficiency of a conventional option plan.

Finally, the deadweight cost analysis suggest that firms who adopt an indexed option plan should consider increasing the cash component *above* the minimal market-market-value-equivalent amount suggested above. Why the increase to the cash component? An indexed option plan, if successfully designed, tightens the link between managerial pay and performance. With this greater degree of incentive alignment, the firm's optimal mix between cash and equity-based compensation may shift towards cash. If the incentive alignment gains from moving to a performance-benchmarked plan are large enough, the firm can produce the same degree of incentive alignment using fewer options. With this decrease in the cost to create a given degree of incentive alignment, the firm can increase the proportion of cash in the compensation package, an increase that will raise the value that managers' place on their compensation, without increasing the firm's cost by a like amount. In fact, any time that a firm can decrease the equity component of compensation, while maintaining the desired degree of incentive alignment, it has an opportunity to increase shareholder value.

In sum, compensation committees need to carefully consider the benefits offered by indexing, contrasting the benefits with the deadweight costs described in this paper. If a firm does move forward with an indexing scheme, it should avoid a structure that links the *exercise price* with the benchmark index, instead relying upon an option on an appropriate *performance-benchmarked portfolio* with a *fixed* exercise price as outlined above. The best performance-benchmarked portfolio will remove not only market (systematic) risk, but also as much idiosyncratic risk as possible, as long as that risk is not under managers' control. After determining the best performance-benchmarked portfolio, firms adopting such a plan need to re-evaluate the appropriate mix of cash and options in the compensation plan, considering whether they can increase the cash component while maintaining the desired degree of incentive alignment.

Appendix

This appendix details the derivation of the market- and industry-adjusted portfolio for stock j. The derivation has two steps. First we create a portfolio for industry that is hedged against the market (referred to in the text as the industry ex-market portfolio).[33] Then we use the industry ex-market portfolio to create the stock j portfolio hedged against market and industry effects.

Terminology and definitions:

$V_j(t)$ denote the price of stock *j* at time *t*

$V_m(t)$ denote the value of a market portfolio (with all dividends reinvested)

$V_i(t)$ denote the value of an industry portfolio (with all dividends reinvested for stock *j*'s industry)

$$\frac{dV_j}{V_j} = r_j\, dt + s_j\, dZ_j \tag{1}$$

$$\frac{dV_m}{V_m} = r_m\, dt + s_m\, dZ_m \tag{2}$$

$$\frac{dV_i}{V_i} = r_i\, dt + s_i\, dZ_i \tag{3}$$

CAPM (continuous-time) obtains so,

$$r_j = r_f + b_j\left(r_m - r_f\right) \tag{4a}$$

where $b_j = \dfrac{\operatorname{cov}\left(dZ_j, dZ_m\right) s_j}{s_m}$, r_{jm} = correlation between firm *j*'s returns and the market return, which is equal to $\operatorname{cov}\left(dZ_i, dZ_m\right)$.

$$r_i = r_f + b_i\left(r_m - r_f\right) \tag{4b}$$

[33] Note that the derivation of the stock j market-adjusted portfolio exactly parallels that of the industry ex-market portfolio detailed below (substitute stock *j* for industry *i* in the proof).

where $b_i = \dfrac{\operatorname{cov}\left(dZ_i, dZ_m\right)\ s_i}{s_m}$ and r_{im} = correlation between industry and market returns $= \operatorname{cov}\left(d\,Z_i, d\,Z_m\right)$

A. Create A Portfolio for Industry (hedged against the market)

Let $P_i(t)$ = value of this (ex-market) portfolio for industry

We can decompose dZ_i into a component correlated with the market and a component uncorrelated with the market:

$$dZ_i \equiv r_{im}\, dZ_m + g_i\, de_i \qquad (5)$$

where de_i is defined by (5), where $g_i \equiv \sqrt{\left(1 - r_{im}^2\right)}$ and where $\operatorname{cov}\left(de_i,\ dZ_m\right) = 0$

From (3) and (5),

$$\frac{dV_i}{V_i} \;=\; r_i d\,t + s_i\, r_{im}\, dZ_m + s_i g_i\, de_i \qquad (6)$$

Suppose we create a portfolio with a strategy in which we invest

i) fraction 1.0 (= 100%) long in industry portfolio *i*

ii) fraction w_i short in the market portfolio

iii) fraction w_i long in the riskless asset.

If P_i = value of the portfolio, then

$$\frac{dP_i}{P_i} \;=\; \frac{dV_i}{V_i} - w_i\left(\frac{dV_m}{V_m} - r_f\, dt\right)$$

$$\;=\; \left(r_i - w_i\left(r_m - r_f\right)\right)dt \;+\; \left(s_i\, r_m - w_i\, s_m\right)dZ_m \;+\; s_i g_i\, de_i \qquad (7)$$

If we set $w_i = b_i = \dfrac{s_i r_{im}}{s_m}$, then from (7) and (4b), the return on the (ex-market) industry portfolio is

$$\frac{dP_i}{P_i} = r_f\, dt + s_i g_i\, de_i \tag{8}$$

B. Create a portfolio for stock j which is hedged against the market and against industry returns

Suppose we create a portfolio with a strategy in which we invest:

i) fraction 1 (=100%) long in the stock j

ii) *shorts* fraction b_j in the market portfolio

iii) *shorts* fraction x_j in the industry (ex-market) portfolio

iv) goes long fraction $\left(x_j + b_j\right)$ in the riskless asset

Let $P_j(t) =$ value of this "stock j-indexed" portfolio

If we decompose dZ_j into a component correlated with the market $\left(dZ_m\right)$, and a component orthogonal to the market, we get

$$dZ_j = r_{jm} dZ_m + g_j de_j \tag{9}$$

where de_j is defined by (9), $g_j = \sqrt{\left(1 - r_{jm}^2\right)}$ and $\operatorname{cov}\left(de_j, dZ_m\right) = 0$

If we decompose de_j into a component correlated with the industry (de_i) and an orthogonal component, then we get

$$de_j = h_{ji} de_i + d_j dq_j \tag{10}$$

where dq_j is defined by (10), $d_j = \sqrt{\left(1 - h_{ji}^2\right)}$, and $\operatorname{cov}\left(dq_j, de_i\right) = 0$, $\operatorname{cov}\left(dq_j, dZ_m\right) = 0$

From (1), (9), (10)

$$\frac{dV_j}{V_j} = r_j dt + s_j\left[r_{jm} dZ_m + g_j h_{ji} de_i + g_j d_j dq_j\right] \tag{11}$$

$$= r_j dt + s_j r_{jm}\, dZ_m + g_j s_j h_{ji} de_i + g_j s_j d_j\, dq_j$$

By the proposed strategy, we have that

$$\frac{dP_j}{P_j} = \frac{dV_j}{V_j} - b_j\left(\frac{dV_{jm}}{V_m} - r_j\right)dt - x_j\left(\frac{dP_i}{P_i} - r_f\right)dt \tag{12}$$

$$= \left(r_j - b_j\left(r_m - r_f\right)\right)dt + \left(s_j dZ_j - b_j s_m dZ_m - x_j s_i g_i de\right) \qquad \text{(from (1), (2), (8))}$$

$$= r_f dt + \left(s_j r_{jm} - b_j s_m\right)dZ_m + \left(g_j s_j h_{ji} - x_j s_i g_i\right)de_i + g_j s_j d_j dq_j$$ (from (11) and (4a))

Now, if we select $x_j = \dfrac{g_j s_j h_{ji}}{g_i s_i}$, then

$$\frac{dP_j}{P_j} = r_f dt + s_j' dq_j$$

where dq_j is uncorrelated with the industry and the market portfolios, and where

$s_j' \equiv \left(g_j d_j\right) s_j$ which is $\leq s_j$

We can therefore create a program of options (or other contingent claims) on firm performance that is not related to either market or industry returns (purely idiosyncratic risk) with the features that:

$$\frac{dP_j}{P_j} = r_f dt + s_j' dq_j$$

where the porfolio has fraction 1 in stock j, fraction b_j short in the market portfolio, fraction $\frac{g_j s_j h_{ji}}{g_i s_i}$ short in the industry (ex-market) portfolio, and $\left[\frac{g_j s_j h_{ji}}{g_i s_i} + b_j\right]$ in the riskless asset.

Equivalently, this can also be expressed as a portfolio with fraction 1 in stock j, fraction $\frac{g_j s_j h_{ji}}{g_i s_i}$ short in industry portfolio, fraction $b_j\left[1-\left(\frac{b_i}{b_j}\right)\left(\frac{s_j}{s_i}\right)\sqrt{\left[\frac{1-r_{jm}^2}{1-r_{im}^2}\right]}\,h_{ji}\right]$ short in the market, and $\left[\frac{g_j s_j h_{ji}}{g_i s_i} + b_j\right]$ in the riskless asset.

The industry- and market-adjusted portfolio can therefore be expressed as:

$$\frac{dP_j}{P_j} = r_f\,dt + l_j s_j\,dq_j$$

where $l_j = g_j d_j = \sqrt{\left(1-r_{jm}^2\right)\left(1-h_{ji}^2\right)}$

References

Aggarwal, Rajesh K., and Andrew A. Samwick, 1999, The Other Side of the Trade-off: The Impact of Risk on Executive Compensation, *Journal of Political Economy* 107, 65-105.

Akhigbe, Aigbe, and Jeff Madura, 1996, Market-Controlled Stock Options: A New Approach to Executive Compensation, *Journal of Applied Corporate Finance* 9, 93-97.

Angel, James J., and Douglas M. McCabe, 1997, Market-Adjusted Options for Executive Compensation, Working Paper.

Antle, Rick, and Abbie Smith, 1986, An Empirical Investigation of the Relative Performance Evaluation of Corporate Executives, *Journal of Accounting Research* 24, 1-38.

Barr, Stephen, 1999, Pay for Underperformance?, *CFO*, July, 83-85.

Bertrand, Marianne, and Sendhil Mullainathan, 1999, Are CEO's Rewarded for Luck? A Test of Performance Filtering, (Princeton University, Mimeograph).

Bettis, J. Carr, John M. Bizjak, and Michael L. Lemmon, 1999, Insider Trading in Derivative Securities: An Empirical Examination of Zero-Cost Collars and Equity Swaps by Corporate Insiders, Working Paper.

Black, Fischer, and Myron Scholes, 1973, The Pricing of Options and Corporate Liabilities, *Journal of Political Economy* 81, 637-54.

Bolster, Paul, Don Chance, and Don Rich, 1986, Executive equity swaps and corporate insider holdings, *Financial Management* 25, 14-24.

Brenner, Meanchem, Rangarajan K. Sundaram, and David Yermack, 2000, Altering the Terms of Executive Stock Options, *Journal of Financial Economics* 57, 103-128.

Cairncross, Frances, 1999, Survey: Pay: Who wants to be a billionaire?, *The Economist*, May 8, S14-S17.

Carpenter, Jennifer N., 1998, The Exercise and Valuation of Executive Stock Options, *Journal of Financial Economics* 48, 127-158.

Carpenter, Jennifer N., 2000, Does Option Compensation Increase Managerial Risk Appetite?, *Journal of Finance* 55, 2311-2332.

Carter, Mary Ellen, and Luann J. Lynch, 2001, An Examination of Executive Stock Option Repricing, *Journal of Financial Economics* 61, 207-225.

Chance, Don M., Raman Kumar, and Rebecca B. Todd, 2000, The "repricing" of executive stock options, *Journal of Financial Economics* 57, 129-154.

Detemple, Jerome, and Suresh Sundaresan, 1999, Nontraded Asset Valuation with Portfolio Constraints: A Binomial Approach, *The Review of Financial Studies* 12, 835-872.

Fischer, S., 1978, Call Option Pricing When the Excercise Price is Uncertain, and the Valuation of Index Bonds, *Journal of Finance* 33, 169-176.

Gibbons, Robert, and Kevin J. Murphy, 1990, Relative Performance Evaluation for Chief Executive Officers, *Industrial and Labor Relations Review* 43, 30-51.

Gilson, Stuart C., and Michael R. Vetsuypens, 1993, CEO Compensation in Financially Distressed Firms: An Empirical Analysis, *Journal of Finance* 48, 425-458.

Hall, Brian J., and Jeffey B. Liebman, 1998, Are CEOs really paid like bureaucrats?, *The Quarterly Journal of Economics* 113, 653-691.

Hall, Brian J., and Kevin J. Murphy, 2000a, Optimal Excercise Prices for Executive Stock Options, *American Economic Review* 90, 209-214.

Hall, Brian J., and Kevin J. Murphy, 2000b, Stock Options for Undiversifed Executives, Working Paper.

Himmelberg, Charles P., and R. Glenn Hubbard, 2000, Incentive Pay and the Market for CEO's: An Analysis of Pay-for-Performance Sensitivity, Columbia Business School Working Paper.

Holmstrom, Bengt, 1982, Moral Hazard in Teams, *Bell Journal of Economics* 13, 324-340.

Huddart, Steven, 1994, Employee Stock Options, *Journal of Accounting and Economics* 18, 207-231.

Janakiraman, Surya N., Richard A. Lambert, and David F. Larcker, 1992, An Empirical Investigation of the Relative Performance Evaluation Hypothesis, *Journal of Accounting Research* 30, 53-69.

Jin, Li, 2000, CEO Compensation, Risk Sharing, and Incentives: Theory and Empirical Results, (Massachusetts Institute of Technology, Cambridge, MA) Thesis.

Jin, Li, and Lisa K. Meulbroek, 2001, The effect of stock price movements on managerial incentive-alignment: Do executive stock options still work?, Working Paper.

Johnson, Alan, 1999, Should Options Reward Absolute or Relative Shareholder Returns?, *Compensation and Benefits Review*.

Johnson, Shane A., and Yisong S. Tian, 2000, Indexed Executive Stock Options, *Journal of Financial Economics* 57, 35-64.

Kay, Ira T., 1999, *Compensation and Benefits Review*.

Lambert, Richard A., David F. Larcker, and Robert E. Verrecchia, 1991, Portfolio Considerations in Valuing Executive Compensation, *Journal of Accounting Research* 29, 129-149.

Levmore, Saul, 2000, Puzzling Stock Options and Compensation Norms, University of Chicago John. M. Olin Law and Economics Working Paper.

Margrabe, W., 1978, The Value of an Option to Exchange One Asset for Another, *Journal of Finance* 33, 177-186.

Merton, Robert C., 1973, Theory of Rational Option Pricing, *Bell Journal of Economics and Management Science* 4, 141-183.

Merton, Robert C., 1992. *Continuous-Time Finance* (Blackwell, Cambridge, MA).

Meulbroek, Lisa, 2001a, The Efficiency of Equity-Linked Compensation: Understanding the Full Cost of Awarding Executive Stock Options, *Financial Management* 30, 5-30.

Meulbroek, Lisa, 2001b, Level 3 Communications, Inc., (Harvard Business School, Boston, MA), No. 201-069.

Murphy, Kevin J., 1998, Executive Compensation, in O. Ashenfelter and D. Card, ed.: *Handbook of Labor Economics*, (North-Holland, Amsterdam),

Nalbantian, Haig R., 1993, Performance Indexing in Stock Option and Other Incentive Compensation Programs, *Compensation and Benefits Review* 25, 25-40.

Oyer, Paul, 2000, Why Do Firms Use Incentives That Have No Incentive Effects?, Stanford University Working Paper.

Rappaport, Alfred, 1999, New Thinking on How to Link Executive Pay with Performance, *Harvard Business Review*, 91-101.

Reingold, Jennifer, 2000, An Option Plan Your CEO Hates, *Business Week*, February 28, 2000, 82-88.

Saly, P. Jane, 1994, Repricing Executive Stock Options in a Down Market, *Journal of Accounting and Economics* 18, 325-356.

Schizer, David, 2001, Tax Constraints on Indexed Options, *Journal of Taxation and Investments* 18, 348-359.

Schizer, David M., 2000, Executives and Hedging: The Fragile Legal Foundation of Incentive Compatability, *Columbia Law Review* 100, 440-504.

Sloan, Richard G., 1993, Accounting Earnings and Top Executive Compensation, *Journal of Accounting and Economics* 16, 55-100.

Stafford, Erik, 2001, Managing Financial Policy: Evidence from the Financing of Major Investments, Working Paper.

Stulz, Rene M, 1982, Options on the Minimum or the Maximum of Two Risky Assets: Analysis and Applications, *Journal of Financial Economics* 10, 161-185.

TABLE 1
Characteristics of Sample Firms
Value Line Industry Survey Firms and H&Q Internet-Based Firms: December 31, 1998

The Panel A dataset consists of 1496 Value Line firms classified into 56 industry classifications as of 12/31/98. Foreign firms and industries are not included in the analysis. The Panel B dataset consists of 53 H&Q Internet firms as of 12/31/98. Continuously-compounded daily excess returns (net of daily riskless rates) are used in all calculations. The market return is the continuously-compounded value-weighted daily NYSE/AMEX/NASDAQ Composite returns (net of daily riskless rates). A minimum of 64 observations (3 months) of daily returns are required for beta and volatility estimation. "Equity Value of the Firm" is measured as of 12/31/98. "Return Premium (s_j)" is the return premium on a stock required by an undiversified manager to compensate for the higher level of risk. "Equity Efficiency" is the ratio of the value of the stock to the undiversified manager to the value of the stock to the diversified investor. "Option Efficiency" is the ratio of the value of the option on the stock to the undiversified manager to the value of the option on the stock to the diversified investor. The vesting period of the stock is 3 years and the time to expiration of options are 3 and 10 years labeled respectively. "n" represents the number of firms.

Panel A: Value Line Firms

	Beta (b_j)	Volatility (s_j)	Equity Value of Firm ($mm)	Sharpe Ratio ($(r_j - r_f)/s_j$)
mean	0.90	0.52	7,509	0.127
median	0.87	0.48	1,517	0.127
std dev	0.40	0.20	22,919	0.039
n	1,496	1,496	1,496	1,496

	Return Premium (s_j)	Equity Efficiency (V_j^u/V_j)	Option Efficiency	
			3 Year Maturity	10 Year Maturity
mean	0.073	0.81	0.67	0.76
median	0.064	0.83	0.67	0.77
std dev	0.041	0.09	0.09	0.08
n	1,496	1,496	1,496	1,496

TABLE 1 (cont.)
Characteristics of Sample Firms
Value Line Industry Survey Firms and H&Q Internet-Based Firms: December 31, 1998

The Panel A dataset consists of 1496 Value Line firms classified into 56 industry classifications as of 12/31/98. Foreign firms and industries are not included in the analysis. The Panel B dataset consists of 53 H&Q Internet firms as of 12/31/98. Continuously-compounded daily excess returns (net of daily riskless rates) are used in all calculations. The market return is the continuously-compounded value-weighted daily NYSE/AMEX/NASDAQ Composite returns (net of daily riskless rates). A minimum of 64 observations (3 months) of daily returns are required for beta and volatility estimation. "Equity Value of the Firm" is measured as of 12/31/98. "Return Premium (s_j)" is the return premium on a stock required by an undiversified manager to compensate for the higher level of risk. "Equity Efficiency" is the ratio of the value of the stock to the undiversified manager to the value of the stock to the diversified investor. "Option Efficiency" is the ratio of the value of the option on the stock to the undiversified manager to the value of the option on the stock to the diversified investor. The vesting period of the stock is 3 years and the time to expiration of options are 3 and 10 years labeled respectively. "n" represents the number of firms

Panel B: Hambrecht & Quist Internet-Based Firms

	Beta (b_j)	Volatility (s_j)	Equity Value of Firm (\$mm)	Sharpe Ratio ($(r_j - r_f)/s_j$)
mean	2.00	1.17	14,128	0.130
median	2.06	1.19	1,216	0.128
std dev	0.47	0.33	51,129	0.033
n	53	53	53	53

	Return Premium (s_j)	Equity Efficiency (V_j^u/V_j)	Option Efficiency	
			3 Year Maturity	10 Year Maturity
mean	0.166	0.62	0.56	0.61
median	0.159	0.62	0.56	0.61
std dev	0.074	0.13	0.12	0.13
n	53	53	53	53

TABLE 2
Industry Characteristics
Value Line Industries and Hambrecht & Quist Internet-Based Industries: December 31, 1998

The dataset consists of 1496 firms tracked by Value Line and 53 firms in Hambrecht & Quist Internet-Based Index as of 12/31/98. The calculations use daily continuously-compounded excess return (net of risk-free rate) over the six month period ending 12/31/98. If six months of data is not available, we use the available data, as long as that data covers at least three months. CRSP's Value-Weighted Composite Index is used for the market return. "Equity Value" is measured as of 12/31/98. "Beta" is a firm-level beta calculated using the market model with excess returns. "Firm Volatility" is the annualized volatility of daily returns. "Industry Volatility" is the annualized volatility of daily returns for a value-weighted industry index comprised of all firms within the specified Value Line Industry. "Firm-Mkt Corr." is the correlation between the firm's excess return and the industry's excess return calculated from daily data. "Firm-Ind. Corr." is the correlation between the firm's return and the "ex-market" industry return (where ex-market means that the market component of the industry return has been removed).

Panel A: Value Line Industries

Industry	Firms	Equity Value on 12/31/98 ($mm)			Beta (b_j)			Firm Volatility (s_j)			Industry Volatility (s_i)	Firm-Mkt Corr. (r_{jm})			Firm-Ind. Corr. (after taking out the mkt) (h_{ij})		
		MEAN	MED	STDDEV	**MEAN**	MED	STDDEV	**MEAN**	MED	STDDEV		**MEAN**	MED	STDDEV	**MEAN**	MED	STDDEV
Advertising, Publishing & Newspaper	33	**3716**	2378	3983	**0.83**	0.83	0.21	**0.41**	0.41	0.11	0.23	**0.56**	0.56	0.11	**0.29**	0.27	0.15
Aerospace & Defense	17	**5186**	1369	8498	**0.74**	0.67	0.27	**0.46**	0.43	0.12	0.30	**0.43**	0.45	0.09	**0.29**	0.30	0.22
Air Transport	14	**4014**	2071	4146	**1.26**	1.25	0.20	**0.58**	0.57	0.09	0.43	**0.59**	0.59	0.06	**0.54**	0.57	0.24
Apparel & Shoe	24	**1259**	552	1798	**0.88**	0.85	0.24	**0.61**	0.63	0.15	0.29	**0.40**	0.41	0.10	**0.26**	0.22	0.17
Auto & Truck	8	**14982**	1140	26408	**1.08**	1.08	0.19	**0.54**	0.51	0.09	0.38	**0.56**	0.54	0.10	**0.29**	0.17	0.28
Auto Parts	24	**2106**	1046	2187	**0.74**	0.70	0.25	**0.47**	0.44	0.15	0.21	**0.45**	0.44	0.15	**0.27**	0.26	0.16
Bank & Thrift	57	**14942**	6336	21215	**1.16**	1.16	0.24	**0.45**	0.43	0.09	0.36	**0.70**	0.71	0.08	**0.33**	0.33	0.20
Beverage	13	**22632**	2022	46221	**0.77**	0.85	0.30	**0.45**	0.47	0.11	0.32	**0.47**	0.49	0.16	**0.17**	0.07	0.30
Broadcasting & Cable TV	4	**9204**	4400	11418	**1.13**	1.17	0.14	**0.53**	0.53	0.09	0.36	**0.59**	0.60	0.05	**0.42**	0.34	0.37
Brokerage, Leasing & Financial Services	36	**12328**	5072	20528	**1.37**	1.42	0.35	**0.61**	0.58	0.16	0.47	**0.62**	0.63	0.09	**0.38**	0.41	0.22
Building Materials, Cement, Furniture & Homebuilding	53	**3382**	835	13218	**0.93**	0.93	0.35	**0.52**	0.51	0.16	0.37	**0.49**	0.50	0.14	**0.11**	0.09	0.17
Chemical	62	**3621**	1285	8562	**0.75**	0.76	0.22	**0.47**	0.43	0.14	0.25	**0.45**	0.45	0.12	**0.18**	0.16	0.19
Coal & Alternate Energy	2	**5304**	5304	4580	**0.94**	0.94	0.27	**0.52**	0.52	0.19	0.54	**0.50**	0.50	0.04	**0.66**	0.66	0.47
Computer	77	**17190**	3468	47556	**1.26**	1.22	0.35	**0.70**	0.68	0.18	0.38	**0.51**	0.50	0.14	**0.18**	0.14	0.20
Diversified	44	**5963**	1381	14750	**0.85**	0.85	0.25	**0.47**	0.43	0.10	0.26	**0.50**	0.52	0.13	**0.10**	0.08	0.17
Drug	37	**25760**	4052	46763	**1.05**	0.97	0.30	**0.57**	0.55	0.21	0.29	**0.52**	0.50	0.12	**0.14**	0.06	0.24
Drugstore	6	**10876**	7160	12416	**1.02**	0.99	0.29	**0.51**	0.47	0.14	0.41	**0.56**	0.58	0.17	**0.36**	0.34	0.45
Educational Services	5	**1160**	1158	738	**1.35**	1.23	0.49	**0.85**	0.64	0.51	0.44	**0.47**	0.49	0.08	**0.47**	0.41	0.21
Electrical Equipment & Home Appliance	25	**17080**	1240	66319	**0.78**	0.79	0.24	**0.43**	0.41	0.12	0.31	**0.51**	0.52	0.15	**0.04**	0.00	0.21
Electronics & Semiconductor	52	**7692**	1137	27801	**1.17**	1.24	0.39	**0.65**	0.67	0.17	0.37	**0.49**	0.50	0.13	**0.23**	0.21	0.21
Food Processing	43	**6006**	1895	9926	**0.68**	0.66	0.20	**0.44**	0.42	0.11	0.21	**0.44**	0.43	0.11	**0.20**	0.15	0.22
Food Wholesalers & Grocery Stores	20	**5696**	2279	7497	**0.68**	0.67	0.23	**0.43**	0.43	0.13	0.23	**0.44**	0.44	0.12	**0.27**	0.18	0.22
Hotel & Gaming	14	**1445**	1064	1397	**0.89**	0.94	0.20	**0.53**	0.53	0.12	0.30	**0.46**	0.47	0.09	**0.39**	0.48	0.21
Household Products	18	**12255**	1441	28612	**0.75**	0.76	0.21	**0.53**	0.43	0.23	0.31	**0.44**	0.48	0.17	**0.18**	0.14	0.27
Industrial Services (Including Environmental)	30	**2999**	1359	5002	**0.95**	0.84	0.40	**0.57**	0.56	0.20	0.31	**0.45**	0.45	0.11	**0.20**	0.16	0.18
Insurance	52	**7843**	4282	14550	**0.91**	0.93	0.29	**0.45**	0.43	0.13	0.30	**0.57**	0.58	0.13	**0.24**	0.24	0.18
Internet	6	**20387**	11498	26229	**2.17**	2.12	0.26	**1.06**	1.14	0.18	0.79	**0.57**	0.56	0.07	**0.69**	0.70	0.20
Investment	41	**499**	202	679	**0.85**	0.94	0.44	**0.38**	0.37	0.17	0.16	**0.60**	0.64	0.20	**0.36**	0.37	0.10
Machinery	42	**1654**	642	3048	**0.82**	0.84	0.29	**0.51**	0.47	0.16	0.27	**0.44**	0.45	0.11	**0.21**	0.20	0.18
Manufactured Housing & Recreational Vehicles	8	**828**	575	625	**0.75**	0.75	0.29	**0.46**	0.45	0.11	0.30	**0.44**	0.46	0.11	**0.44**	0.45	0.21

TABLE 2 (cont.)
Industry Characteristics
Value Line Industries and Hambrecht & Quist Internet-Based Industries: December 31, 1998

The dataset consists of 1496 firms tracked by Value Line and 53 firms in Hambrecht & Quist Internet-Based Index as of 12/31/98. The calculations use daily continuously-compounded excess return (net of risk-free rate) over the six month period ending 12/31/98. If six months of data is not available, we use the available data, as long as that data covers at least three months. CRSP's Value-Weighted Composite Index is used for the market return. "Equity Value" is measured as of 12/31/98. "Beta" is a firm-level beta calculated using the market model with excess returns. "Firm Volatility" is the annualized volatility of daily returns. "Industry Volatility" is the annualized volatility of daily returns for a value-weighted industry index comprised of all firms within the specified Value Line Industry. "Firm-Mkt Corr." is the correlation between the firm's excess return and the industry's excess return calculated from daily data. "Firm-Ind. Corr." is the correlation between the firm's return and the "ex-market" industry return (where ex-market means that the market component of the industry return has been removed).

Panel A (cont.): Value Line Industries

Industry	**Firms**	**Equity Value on 12/31/98 ($mm)**			**Beta (b_j)**			**Firm Volatility (s_j)**			**Industry Volatility (s_i)**	**Firm-Mkt Corr. (r_{jm})**			**Firm-Ind. Corr. (after taking out the mkt) (hij)**		
		MEAN	MED	STDDEV	**MEAN**	MED	STDDEV	**MEAN**	MED	STDDEV		**MEAN**	MED	STDDEV	**MEAN**	MED	STDDEV
Maritime	5	**448**	340	390	**0.65**	0.66	0.08	**0.62**	0.50	0.28	0.29	**0.32**	0.31	0.09	**0.39**	0.40	0.31
Medical Services	23	**3537**	1196	4029	**1.05**	1.04	0.24	**0.77**	0.71	0.28	0.34	**0.41**	0.40	0.14	**0.31**	0.31	0.17
Medical Supplies	45	**7965**	1450	20230	**0.82**	0.79	0.27	**0.53**	0.48	0.21	0.25	**0.44**	0.43	0.13	**0.13**	0.07	0.20
Metal Fabricating	12	**1746**	442	4055	**0.71**	0.69	0.30	**0.48**	0.46	0.13	0.30	**0.42**	0.42	0.15	**0.19**	0.14	0.25
Metals and Mining	19	**2513**	982	3395	**0.60**	0.69	0.42	**0.59**	0.54	0.19	0.35	**0.34**	0.36	0.25	**0.55**	0.55	0.22
Natural Gas	43	**2141**	984	3553	**0.56**	0.52	0.27	**0.35**	0.32	0.14	0.21	**0.44**	0.46	0.11	**0.27**	0.24	0.19
Office Equip. & Supplies	21	**4336**	959	9177	**0.95**	0.93	0.46	**0.65**	0.62	0.31	0.32	**0.42**	0.39	0.17	**0.14**	0.11	0.20
Oilfield Services & Equipment	20	**3296**	1382	5913	**1.28**	1.23	0.21	**0.77**	0.76	0.14	0.57	**0.46**	0.46	0.07	**0.78**	0.82	0.14
Packaging & Container	10	**1990**	1698	1536	**0.76**	0.80	0.16	**0.50**	0.48	0.16	0.28	**0.43**	0.43	0.11	**0.34**	0.27	0.24
Paper & Forest Products	25	**3028**	1990	3357	**0.75**	0.74	0.18	**0.42**	0.40	0.08	0.29	**0.49**	0.50	0.10	**0.49**	0.60	0.25
Petroleum	41	**13515**	3373	30972	**0.77**	0.75	0.21	**0.47**	0.43	0.13	0.25	**0.46**	0.44	0.09	**0.41**	0.45	0.24
Precision Instrument	23	**1917**	476	4827	**1.00**	0.90	0.39	**0.66**	0.64	0.18	0.30	**0.42**	0.44	0.10	**0.16**	0.11	0.20
Railroad	7	**8694**	9059	4988	**0.95**	0.81	0.47	**0.46**	0.38	0.17	0.25	**0.54**	0.54	0.10	**0.47**	0.55	0.16
Recreation	30	**8626**	2242	16790	**1.11**	1.07	0.41	**0.60**	0.54	0.22	0.33	**0.52**	0.57	0.15	**0.19**	0.16	0.15
REIT's	15	**1839**	1190	1483	**0.61**	0.53	0.23	**0.33**	0.29	0.12	0.20	**0.50**	0.48	0.07	**0.49**	0.50	0.18
Restaurant	27	**3134**	590	9904	**0.84**	0.80	0.29	**0.53**	0.51	0.15	0.31	**0.44**	0.46	0.10	**0.13**	0.13	0.19
Retail (Special Lines)	55	**2177**	1001	4536	**1.17**	1.24	0.38	**0.70**	0.67	0.21	0.38	**0.46**	0.50	0.13	**0.19**	0.19	0.16
Retail Store	20	**15845**	4941	39412	**1.18**	1.23	0.27	**0.58**	0.58	0.14	0.38	**0.57**	0.60	0.15	**0.33**	0.30	0.21
Steel	17	**716**	449	882	**0.70**	0.69	0.26	**0.51**	0.50	0.19	0.27	**0.39**	0.34	0.12	**0.34**	0.37	0.20
Telecommunications	41	**24984**	4153	42081	**1.10**	1.05	0.48	**0.62**	0.57	0.25	0.26	**0.49**	0.49	0.14	**0.11**	0.02	0.27
Textile	11	**517**	386	529	**0.80**	0.82	0.27	**0.62**	0.65	0.13	0.34	**0.36**	0.36	0.11	**0.36**	0.34	0.18
Tire & Rubber	5	**2297**	1549	3179	**0.85**	0.78	0.24	**0.42**	0.36	0.15	0.29	**0.56**	0.53	0.08	**0.45**	0.32	0.31
Tobacco	6	**25059**	4487	51655	**0.62**	0.59	0.11	**0.36**	0.35	0.07	0.25	**0.46**	0.46	0.06	**0.40**	0.39	0.34
Toiletries & Cosmetics	5	**14286**	5236	22115	**0.94**	0.96	0.05	**0.45**	0.41	0.07	0.43	**0.57**	0.57	0.08	**0.40**	0.32	0.35
Trucking & Transportation Leasing	15	**765**	636	507	**0.87**	0.93	0.21	**0.59**	0.60	0.11	0.30	**0.40**	0.41	0.09	**0.38**	0.37	0.15
Utilities	88	**3961**	2626	4221	**0.28**	0.26	0.11	**0.25**	0.23	0.06	0.16	**0.31**	0.31	0.09	**0.57**	0.61	0.22
H&Q INTERNET INDEX FIRMS**	53	**14128**	1216	51129	**2.00**	2.06	0.47	**1.17**	1.19	0.33	0.47	**0.49**	0.48	0.12	**0.29**	0.27	0.15
**Not Included in Summary Statistics																	

TABLE 2 (cont.)

Industry Characteristics

Value Line Industries and Hambrecht & Quist Internet-Based Industries: December 31, 1998

The dataset consists of 1496 firms tracked by Value Line and 53 firms in Hambrecht & Quist Internet-Based Index as of 12/31/98. The calculations use daily continuously-compounded excess return (net of risk-free rate) over the six month period ending 12/31/98. If six months of data is not available, we use the available data, as long as that data covers at least three months. CRSP's Value-Weighted Composite Index is used for the market return. "Equity Value" is measured as of 12/31/98. "Beta" is a firm-level beta calculated using the market model with excess returns. "Firm Volatility" is the annualized volatility of daily returns. "Industry Volatility" is the annualized volatility of daily returns for a value-weighted industry index comprised of all firms within the specified Value Line Industry. "Firm-Mkt Corr." is the correlation between the firm's excess return and the industry's excess return calculated from daily data. "Firm-Ind. Corr." is the correlation between the firm's return and the "ex-market" industry return (where ex-market means that the market component of the industry return has been removed).

Panel A (cont.): Value Line Industries

Summary Statistics Across Industries and Across Firms

		# of Firms	Equity Value on 12/31/98 ($mm)	Beta (b_j)	Firm Volatility (s_j)	Industry Volatility (s_i)	Firm-Mkt Corr. (r_{jm})	Firm-Ind. Corr. (after taking out the mkt) (h_{ij})
Industry Summary Stats (Industries are equally-weighted)	mean	26.7	7274	0.92	0.54	0.32	0.48	0.32
	median	22.0	3987	0.86	0.52	0.30	0.46	0.30
	std dev	19.5	7060	0.28	0.13	0.10	0.08	0.16
	max	88.0	25760	2.17	1.06	0.79	0.70	0.78
	min	2.0	448	0.28	0.25	0.16	0.31	0.04

		# of Firms	Equity Value on 12/31/98 ($mm)	Beta (b_j)	Firm Volatility (s_j)	Industry Volatility (s_i)	Firm-Mkt Corr. (r_{jm})	Firm-Ind. Corr. (after taking out the mkt) (h_{ij})
Firm Summary Stats (Firms are equally-weighted)	mean	-	7509	0.90	0.52	-	0.48	0.28
	median	-	1517	0.87	0.48	-	0.48	0.23
	std dev	-	22919	0.40	0.20	-	0.15	0.25
	max	-	342558	2.53	1.74	-	0.92	0.99
	min	-	13	-0.48	0.12	-	-0.17	-0.25

Panel B: Hambrecht & Quist's Internet-Based Firms

Industry Sub-Category	Firms	Equity Value on 12/31/98 ($mm)			Beta (b_j)			Firm Volatility (s_j)			Industry Volatility (s_i)	Firm-Mkt Corr. (r_{jm})			Firm-Ind. Corr. (after taking out the mkt) (h_{ij})		
		MEAN	MED	STDEV	**MEAN**	MED	STDEV	**MEAN**	MED	STDEV		**MEAN**	MED	STDEV	**MEAN**	MED	STDEV
Commerce	18	**3098**	576	5474	**2.39**	2.09	1.20	**1.51**	1.34	0.61	0.74	**0.43**	0.42	0.10	**0.36**	0.36	0.16
Communications	12	**15142**	1444	41426	**1.95**	2.03	0.35	**1.07**	1.07	0.34	0.56	**0.53**	0.51	0.12	**0.29**	0.27	0.25
Content	13	**8574**	1556	19756	**2.44**	2.31	0.75	**1.31**	1.22	0.48	0.77	**0.53**	0.55	0.13	**0.46**	0.50	0.32
Security	4	**2904**	954	4031	**1.72**	1.65	0.36	**0.91**	0.92	0.20	0.62	**0.52**	0.54	0.09	**0.46**	0.32	0.34
Software	11	**35371**	1080	102334	**1.91**	2.14	0.49	**1.23**	1.23	0.51	0.44	**0.47**	0.46	0.15	**0.25**	0.20	0.29
All H&Q INTERNET INDEX FIRMS	53	**14128**	1216	51129	**2.00**	2.06	0.47	**1.17**	1.19	0.33	0.47	**0.49**	0.48	0.12	**0.29**	0.27	0.15

TABLE 3

Stock and Option-Based Compensation Efficiency for the Firm's Stock and the Three Performance-Benchmarked Market- and/or Industry-Adjusted

"Efficiency" is the undiversified manager's private value for equity-linked compensation divided by the market value of that compensation, assuming a three-year vesting period. "Volatility" is the annualized volatility of the firm's stock or the appropriate performance-benchmarked portfolio calculated from daily return. Option values are priced with the Black-Scholes formula assuming a ten-year maturity; CAPM is used for expected returns. "Conv. Option" is a conventional option on the firm's stock. "Performance-Benchmarked Option" is an option on the market, industry, or market and industry adjusted portfolios. Panel A data consists of 1496 firms tracked by Value Line (VL) Industry Survey (excluding foreign firms and industries), and Panel B is firms in H&Q's Internet Index, both as of 12/31/98. Calculations use daily continously-compounded excess returns (net of the risk-free rate) over the six month period ending 12/31/98. Firms with less than three months of data during this period are excluded. The market return is CRSP's Value-Weighted Composite Index. The industry return is the value-weighted average of all firms in the specified VL or H&Q industry.

Panel A: Portfolios Hedged Against Value-Weighted Market Returns and Value-Weighted Industry Returns

Portfolio Composition		Volatility	Efficiency: Stock of Firm or Performance-Benchmarked Portfolio	Efficiency: Option on Stock or Performance-Benchmarked Portfolio	Ratio of Market Value of Performance-Benchmarked Option to Conv. Option
Stock Only	**mean**	0.519	0.809	0.762	**-**
	median	0.480	0.826	0.773	-
	std dev	0.205	0.090	0.084	-
	n	1,496	1,496	1,496	-
Portfolio Hedged Against Market Returns	**mean**	0.452	0.707	0.617	**0.932**
	median	0.414	0.720	0.624	0.940
	std dev	0.196	0.100	0.073	0.045
	n	1,496	1,496	1,496	1,496
Portfolio Hedged Against Industry Returns	**mean**	0.417	0.725	0.631	**0.900**
	median	0.381	0.737	0.636	0.915
	std dev	0.182	0.105	0.079	0.071
	n	1,496	1,496	1,496	1,496
Portfolio Hedged Against Market and Industry Returns	**mean**	0.420	0.720	0.627	**0.909**
	median	0.385	0.731	0.632	0.927
	std dev	0.199	0.106	0.079	0.072
	n	1,496	1,496	1,496	1,496

TABLE 4

Industry-Level Summary Statistics for Efficiency of Compensation for Conventional Stock Option, and Option on Indexed Portfolio (Hedged Against Market Movements, Industry Movements, or Both)

"Efficiency" is the undiversified manager's private value for equity-linked compensation divided by the market value of that compensation, assuming a three-year vesting period. "Volatility" is the annualized volatility of the firm's stock or the appropriate performance-benchmarked portfolio calculated from daily return. Option values are priced with the Black-Scholes formula assuming a ten-year maturity; CAPM is used for expected returns. "Conventional Option" is a conventional option on the firm's stock. "Performance-Benchmarked Option" is an option on the market, industry, or market and industry adjusted portfolios. Panel A data consists of 1496 firms tracked by Value Line (VL) Industry Survey (excluding foreign firms and industries), and Panel B is firms in H&Q's Internet Index, both as of 12/31/98. Calculations use daily continously-compounded excess returns (net of the risk-free rate) over the six month period ending 12/31/98. Firms with less than three months of data during this period are excluded. The market return is CRSP's Value-Weighted Composite Index. The industry return is the value-weighted average of all firms in the specified VL or H&Q industry.

	Efficiency of Option on				Ratio of Market Value of Performance-Benchmarked Option to Conventional Option		
Industry	**Firm's Stock Only (Conv. Option)**	**Market-Hedged Portfolio**	**Industry-Hedged Portfolio**	**Market & Industry Hedged Port.**	**Market-Hedged Portfolio**	**Industry-Hedged Portfolio**	**Market & Industry Hedged Port.**
Advertising, Publishing & Newspaper	0.81	0.66	0.66	0.67	0.92	0.90	0.89
	(0.06)	(0.05)	(0.05)	(0.05)	(0.03)	(0.04)	(0.04)
Aerospace & Defense	0.76	0.63	0.64	0.64	0.95	0.93	0.91
	(0.04)	(0.04)	(0.04)	(0.04)	(0.02)	(0.07)	(0.06)
Air Transport	0.79	0.60	0.64	0.64	0.90	0.81	0.81
	(0.03)	(0.03)	(0.06)	(0.05)	(0.02)	(0.10)	(0.09)
Apparel & Shoe	0.71	0.57	0.58	0.58	0.96	0.94	0.93
	(0.07)	(0.05)	(0.06)	(0.06)	(0.02)	(0.04)	(0.04)
Auto & Truck	0.79	0.61	0.62	0.63	0.91	0.88	0.87
	(0.05)	(0.04)	(0.06)	(0.06)	(0.04)	(0.10)	(0.10)
Auto Parts	0.76	0.63	0.63	0.64	0.94	0.92	0.92
	(0.08)	(0.06)	(0.06)	(0.07)	(0.04)	(0.05)	(0.05)
Bank & Thrift	0.87	0.67	0.67	0.68	0.85	0.83	0.82
	(0.04)	(0.03)	(0.04)	(0.04)	(0.04)	(0.06)	(0.06)
Beverage	0.77	0.64	0.64	0.65	0.94	0.93	0.91
	(0.07)	(0.04)	(0.06)	(0.06)	(0.04)	(0.09)	(0.08)
Broadcasting & Cable TV	0.80	0.62	0.65	0.66	0.90	0.84	0.82
	(0.04)	(0.03)	(0.10)	(0.10)	(0.02)	(0.13)	(0.12)
Brokerage, Leasing & Financial Services	0.80	0.60	0.62	0.62	0.89	0.85	0.84
	(0.06)	(0.05)	(0.05)	(0.05)	(0.04)	(0.07)	(0.07)
Building Materials, Cement, Furniture & Homebuilding	0.77	0.61	0.61	0.62	0.93	0.93	0.92
	(0.08)	(0.06)	(0.06)	(0.06)	(0.05)	(0.06)	(0.06)
Chemical	0.76	0.62	0.62	0.63	0.94	0.94	0.93
	(0.07)	(0.05)	(0.06)	(0.06)	(0.03)	(0.05)	(0.05)
Coal & Alternate Energy	0.77	0.61	0.75	0.75	0.93	0.72	0.71
	(0.06)	(0.07)	(0.12)	(0.12)	(0.01)	(0.29)	(0.27)
Computer	0.73	0.56	0.56	0.57	0.92	0.92	0.91
	(0.09)	(0.07)	(0.07)	(0.07)	(0.05)	(0.07)	(0.07)
Diversified	0.78	0.63	0.63	0.63	0.93	0.93	0.92
	(0.06)	(0.04)	(0.04)	(0.04)	(0.04)	(0.05)	(0.05)
Drug	0.76	0.60	0.60	0.61	0.92	0.92	0.91
	(0.09)	(0.08)	(0.08)	(0.08)	(0.04)	(0.07)	(0.06)
Drugstore	0.79	0.63	0.65	0.66	0.90	0.84	0.83
	(0.10)	(0.06)	(0.09)	(0.09)	(0.07)	(0.16)	(0.15)
Educational Services	0.67	0.52	0.55	0.55	0.95	0.88	0.88
	(0.16)	(0.14)	(0.15)	(0.15)	(0.03)	(0.09)	(0.09)

TABLE 4 (cont.)

Industry-Level Summary Statistics for Efficiency of Compensation for Conventional Stock Option, and Option on Indexed Portfolio (Hedged Against Market Movements, Industry Movements, or Both)

"Efficiency" is the undiversified manager's private value for equity-linked compensation divided by the market value of that compensation, assuming a three-year vesting period. "Volatility" is the annualized volatility of the firm's stock or the appropriate performance-benchmarked portfolio calculated from daily return. Option values are priced with the Black-Scholes formula assuming a ten-year maturity; CAPM is used for expected returns. "Conventional Option" is a conventional option on the firm's stock. "Performance-Benchmarked Option" is an option on the market, industry, or market and industry adjusted portfolios. Panel A data consists of 1496 firms tracked by Value Line (VL) Industry Survey (excluding foreign firms and industries), and Panel B is firms in H&Q's Internet Index, both as of 12/31/98. Calculations use daily continously-compounded excess returns (net of the risk-free rate) over the six month period ending 12/31/98. Firms with less than three months of data during this period are excluded. The market return is CRSP's Value-Weighted Composite Index. The industry return is the value-weighted average of all firms in the specified VL or H&Q industry.

	Efficiency of Option on				Ratio of Market Value of Performance-Benchmarked Option to Conventional Option		
Industry	**Firm's Stock Only (Conv. Option)**	**Market-Hedged Portfolio**	**Industry-Hedged Portfolio**	**Market & Industry Hedged Port.**	**Market-Hedged Portfolio**	**Industry-Hedged Portfolio**	**Market & Industry Hedged Port.**
Electrical Equipment & Home Appliance	0.79	0.64	0.65	0.65	0.93	0.94	0.92
	(0.07)	(0.05)	(0.07)	(0.07)	(0.05)	(0.06)	(0.06)
Electronics & Semiconductor	0.73	0.57	0.58	0.58	0.93	0.91	0.91
	(0.07)	(0.06)	(0.06)	(0.06)	(0.04)	(0.07)	(0.07)
Food Processing	0.76	0.63	0.64	0.64	0.95	0.94	0.93
	(0.06)	(0.05)	(0.05)	(0.05)	(0.03)	(0.05)	(0.05)
Food Wholesalers & Grocery Stores	0.77	0.64	0.65	0.65	0.95	0.93	0.92
	(0.07)	(0.05)	(0.06)	(0.06)	(0.03)	(0.06)	(0.06)
Hotel & Gaming	0.75	0.60	0.62	0.62	0.94	0.90	0.89
	(0.05)	(0.04)	(0.05)	(0.05)	(0.03)	(0.06)	(0.05)
Household Products	0.74	0.61	0.61	0.62	0.94	0.93	0.92
	(0.12)	(0.09)	(0.10)	(0.10)	(0.04)	(0.08)	(0.09)
Industrial Services (Including Environmental)	0.74	0.59	0.60	0.60	0.95	0.94	0.93
	(0.06)	(0.06)	(0.06)	(0.06)	(0.03)	(0.04)	(0.05)
Insurance	0.81	0.65	0.65	0.65	0.91	0.89	0.89
	(0.07)	(0.05)	(0.05)	(0.05)	(0.04)	(0.06)	(0.06)
Internet	0.68	0.47	0.55	0.55	0.93	0.79	0.79
	(0.07)	(0.06)	(0.10)	(0.10)	(0.04)	(0.14)	(0.14)
Investment	0.85	0.69	0.70	0.70	0.90	0.88	0.87
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.06)
Machinery	0.75	0.61	0.62	0.62	0.95	0.93	0.93
	(0.06)	(0.06)	(0.06)	(0.06)	(0.03)	(0.05)	(0.05)
Manufactured Housing & Recreational Vehicles	0.76	0.63	0.65	0.65	0.95	0.89	0.89
	(0.04)	(0.04)	(0.04)	(0.04)	(0.03)	(0.08)	(0.08)
Maritime	0.67	0.56	0.59	0.59	0.97	0.91	0.91
	(0.11)	(0.09)	(0.11)	(0.11)	(0.02)	(0.08)	(0.08)
Medical Services	0.66	0.52	0.54	0.54	0.95	0.93	0.92
	(0.13)	(0.10)	(0.10)	(0.10)	(0.04)	(0.05)	(0.05)
Medical Supplies	0.74	0.60	0.60	0.61	0.95	0.94	0.93
	(0.09)	(0.07)	(0.08)	(0.08)	(0.04)	(0.05)	(0.05)
Metal Fabricating	0.74	0.62	0.63	0.63	0.95	0.94	0.93
	(0.08)	(0.05)	(0.08)	(0.08)	(0.03)	(0.09)	(0.09)
Metals and Mining	0.68	0.58	0.61	0.63	0.95	0.88	0.85
	(0.15)	(0.08)	(0.06)	(0.06)	(0.05)	(0.06)	(0.07)
Natural Gas	0.79	0.67	0.68	0.68	0.95	0.94	0.93
	(0.05)	(0.06)	(0.05)	(0.05)	(0.02)	(0.04)	(0.04)

TABLE 4 (cont.)

Industry-Level Summary Statistics for Efficiency of Compensation for Conventional Stock Option, and Option on Indexed Portfolio (Hedged Against Market Movements, Industry Movements, or Both)

"Efficiency" is the undiversified manager's private value for equity-linked compensation divided by the market value of that compensation, assuming a three-year vesting period. "Volatility" is the annualized volatility of the firm's stock or the appropriate performance-benchmarked portfolio calculated from daily return. Option values are priced with the Black-Scholes formula assuming a ten-year maturity; CAPM is used for expected returns. "Conventional Option" is a conventional option on the firm's stock. "Performance-Benchmarked Option" is an option on the market, industry, or market and industry adjusted portfolios. Panel A data consists of 1496 firms tracked by Value Line (VL) Industry Survey (excluding foreign firms and industries), and Panel B is firms in H&Q's Internet Index, both as of 12/31/98. Calculations use daily continously-compounded excess returns (net of the risk-free rate) over the six month period ending 12/31/98. Firms with less than three months of data during this period are excluded. The market return is CRSP's Value-Weighted Composite Index. The industry return is the value-weighted average of all firms in the specified VL or H&Q industry.

	Efficiency of Option on				Ratio of Market Value of Performance-Benchmarked Option to Conventional Option		
Industry	Firm's Stock Only (Conv. Option)	Market-Hedged Portfolio	Industry-Hedged Portfolio	Market & Industry Hedged Port.	Market-Hedged Portfolio	Industry-Hedged Portfolio	Market & Industry Hedged Port.
Office Equip. & Supplies	0.70	0.57	0.57	0.57	0.95	0.94	0.93
	(0.12)	(0.10)	(0.10)	(0.10)	(0.05)	(0.07)	(0.07)
Oilfield Services & Equipment	0.69	0.53	0.62	0.63	0.95	0.75	0.74
	(0.06)	(0.05)	(0.05)	(0.05)	(0.02)	(0.08)	(0.08)
Packaging & Container	0.74	0.61	0.62	0.63	0.95	0.91	0.90
	(0.08)	(0.06)	(0.06)	(0.06)	(0.03)	(0.06)	(0.07)
Paper & Forest Products	0.79	0.65	0.67	0.68	0.93	0.87	0.86
	(0.05)	(0.03)	(0.04)	(0.04)	(0.03)	(0.08)	(0.07)
Petroleum	0.77	0.63	0.64	0.65	0.94	0.90	0.89
	(0.06)	(0.05)	(0.06)	(0.06)	(0.02)	(0.06)	(0.06)
Precision Instrument	0.70	0.56	0.56	0.57	0.96	0.95	0.94
	(0.06)	(0.06)	(0.07)	(0.07)	(0.02)	(0.06)	(0.06)
Railroad	0.80	0.64	0.66	0.66	0.92	0.87	0.86
	(0.04)	(0.05)	(0.06)	(0.06)	(0.04)	(0.04)	(0.04)
Recreation	0.76	0.59	0.59	0.60	0.92	0.91	0.91
	(0.10)	(0.08)	(0.08)	(0.08)	(0.04)	(0.05)	(0.05)
REIT's	0.82	0.68	0.70	0.71	0.94	0.89	0.89
	(0.04)	(0.05)	(0.05)	(0.05)	(0.02)	(0.05)	(0.05)
Restaurant	0.74	0.60	0.60	0.61	0.95	0.95	0.93
	(0.06)	(0.05)	(0.06)	(0.07)	(0.02)	(0.06)	(0.06)
Retail (Special Lines)	0.71	0.55	0.56	0.56	0.94	0.93	0.92
	(0.09)	(0.07)	(0.07)	(0.07)	(0.04)	(0.05)	(0.05)
Retail Store	0.78	0.60	0.62	0.62	0.90	0.87	0.87
	(0.09)	(0.06)	(0.07)	(0.07)	(0.05)	(0.09)	(0.09)
Steel	0.73	0.61	0.62	0.62	0.96	0.93	0.92
	(0.08)	(0.07)	(0.07)	(0.07)	(0.03)	(0.06)	(0.06)
Telecommunications	0.74	0.58	0.58	0.59	0.93	0.94	0.91
	(0.09)	(0.08)	(0.09)	(0.09)	(0.05)	(0.05)	(0.05)
Textile	0.68	0.56	0.58	0.58	0.97	0.93	0.92
	(0.06)	(0.05)	(0.05)	(0.05)	(0.02)	(0.05)	(0.05)
Tire & Rubber	0.81	0.65	0.69	0.70	0.92	0.87	0.85
	(0.06)	(0.06)	(0.11)	(0.11)	(0.03)	(0.10)	(0.10)
Tobacco	0.79	0.66	0.70	0.71	0.95	0.91	0.90
	(0.03)	(0.03)	(0.12)	(0.11)	(0.01)	(0.08)	(0.07)
Toiletries & Cosmetics	0.81	0.64	0.68	0.70	0.91	0.86	0.82
	(0.05)	(0.03)	(0.09)	(0.09)	(0.03)	(0.16)	(0.14)

TABLE 4 (cont.)

Industry-Level Summary Statistics for Efficiency of Compensation for Conventional Stock Option, and Option on Indexed Portfolio (Hedged Against Market Movements, Industry Movements, or Both)

"Efficiency" is the undiversified manager's private value for equity-linked compensation divided by the market value of that compensation, assuming a three-year vesting period. "Volatility" is the annualized volatility of the firm's stock or the appropriate performance-benchmarked portfolio calculated from daily return. Option values are priced with the Black-Scholes formula assuming a ten-year maturity; CAPM is used for expected returns. "Conventional Option" is a conventional option on the firm's stock. "Performance-Benchmarked Option" is an option on the market, industry, or market and industry adjusted portfolios. Panel A data consists of 1496 firms tracked by Value Line (VL) Industry Survey (excluding foreign firms and industries), and Panel B is firms in H&Q's Internet Index, both as of 12/31/98. Calculations use daily continously-compounded excess returns (net of the risk-free rate) over the six month period ending 12/31/98. Firms with less than three months of data during this period are excluded. The market return is CRSP's Value-Weighted Composite Index. The industry return is the value-weighted average of all firms in the specified VL or H&Q industry.

	Efficiency of Option on				Ratio of Market Value of Performance-Benchmarked Option to Conventional Option		
Industry	**Firm's Stock Only (Conv. Option)**	**Market-Hedged Portfolio**	**Industry-Hedged Portfolio**	**Market & Industry Hedged Port.**	**Market-Hedged Portfolio**	**Industry-Hedged Portfolio**	**Market & Industry Hedged Port.**
Trucking & Transportation Leasing	0.71	0.58	0.59	0.59	0.96	0.92	0.91
	(0.05)	(0.04)	(0.04)	(0.04)	(0.02)	(0.04)	(0.05)
Utilities	0.79	0.71	0.74	0.74	0.98	0.92	0.92
	(0.03)	(0.03)	(0.05)	(0.05)	(0.01)	(0.04)	(0.03)
H&Q INTERNET INDEX FIRMS**	0.61	0.43	0.44	0.44	0.95	0.94	0.94
**Not Included in Summary Stats Below	(0.13)	(0.10)	(0.10)	(0.10)	(0.05)	(0.07)	(0.07)

Industry-Level Summary Statistics (Equally-weighting each industry)	Efficiency of Option on				Ratio of Market Value of Performance-Benchmarked Option to Conventional Option		
	Firm's Stock Only (Conv. Option)	**Market-Hedged Portfolio**	**Industry-Hedged Portfolio**	**Market & Industry Hedged Port.**	**Market-Hedged Portfolio**	**Industry-Hedged Portfolio**	**Market & Industry Hedged Port.**
mean	**0.76**	**0.61**	**0.63**	**0.63**	**0.93**	**0.90**	**0.89**
median	**0.76**	**0.61**	**0.62**	**0.63**	**0.94**	**0.92**	**0.91**
std dev	**0.05**	**0.04**	**0.05**	**0.05**	**0.02**	**0.05**	**0.05**
max	**0.87**	**0.71**	**0.75**	**0.75**	**0.98**	**0.95**	**0.94**
min	**0.66**	**0.47**	**0.54**	**0.54**	**0.85**	**0.72**	**0.71**

TABLE 5

The Efficiency Effect of Supplementing the Options on the Performance-Benchmarked Indexed Portfolio with Cash Amounting to the Difference in Market Value Between a Conventional Option and the Performance-Benchmarked Indexed Portfolio

"Efficiency" is the undiversified manager's private value for equity-linked compensation divided by the market value of that compensation, assuming a three-year vesting period. Option values are priced with the Black-Scholes formula assuming a ten-year maturity; CAPM is used for expected returns. "Conv. Option" is a conventional option on the firm's stock. "Performance-Benchmarked Option" is an option on the market, industry, or market and industry adjusted portfolios. "Market-Value-Equivalent Cash Supplement" is the difference between the market value of a conventional option and an option on one of these performance-benchmarked indexed portfolios. Panel A data consists of 1496 firms tracked by Value Line (VL) Industry Survey (excluding foreign firms and industries), and Panel B is firms in H&Q's Internet Index, both as of 12/31/98. Calculations use daily continously-compounded excess returns (net of the risk-free rate) over the six month period ending 12/31/98. Firms with less than three months of data during this period are excluded. The market return is CRSP's Value-Weighted Composite Index. The industry return is the value-weighted average of all firms in the specified VL or H&Q industry.

Panel A: Value Line Firms

Portfolio Composition		Firm's Stock Only (Conv. Option)	Market-Hedged Portfolio	Industry-Hedged Portfolio	Market and Industry Hedged Portfolio
Stock or	**mean**	0.809	0.707	0.725	0.720
Benchmarked Portfolio	**median**	0.826	0.720	0.737	0.731
Alone	**stddev**	0.090	0.100	0.105	0.106
Option on Stock	**mean**	0.762	0.617	0.631	0.627
or Benchmarked Portfolio	**median**	0.773	0.624	0.636	0.632
Alone	**stddev**	0.084	0.073	0.079	0.079
Market Value of Performance-Benchmarked	**mean**	1.000	0.932	0.900	0.909
Option Relative to Conventional Option	**median**	1.000	0.940	0.915	0.927
(= w)	**stddev**	0.000	0.045	0.071	0.072
Efficiency of Option Portion of Portfolio	**mean**	0.762	0.632	0.658	0.651
When Market-Value-Equivalent Cash	**median**	0.773	0.641	0.657	0.651
Supplement of (1 - w) Paid	**stddev**	0.084	0.080	0.096	0.096
Combined Efficiency of Performance-	**mean**	0.762	0.656	0.688	0.679
Benchmarked Option Plus Market-Value-	**median**	0.773	0.665	0.689	0.681
Equivalent Cash Supplement of (1 - w)	**stddev**	0.084	0.084	0.101	0.102

TABLE 5 (cont.)

The Efficiency Effect of Supplementing the Options on the Performance-Benchmarked Indexed Portfolio with Cash Amounting to the Difference in Market Value Between a Conventional Option and the Performance-Benchmarked Indexed Portfolio

"Efficiency" is the undiversified manager's private value for equity-linked compensation divided by the market value of that compensation, assuming a three-year vesting period. Option values are priced with the Black-Scholes formula assuming a ten-year maturity; CAPM is used for expected returns. "Conv. Option" is a conventional option on the firm's stock. "Performance-Benchmarked Option" is an option on the market, industry, or market and industry adjusted portfolios. "Market-Value-Equivalent Cash Supplement" is the difference between the market value of a conventional option and an option on one of these performance-benchmarked indexed portfolios. Panel A data consists of 1496 firms tracked by Value Line (VL) Industry Survey (excluding foreign firms and industries), and Panel B is firms in H&Q's Internet Index, both as of 12/31/98. Calculations use daily continously-compounded excess returns (net of the risk-free rate) over the six month period ending 12/31/98. Firms with less than three months of data during this period are excluded. The market return is CRSP's Value-Weighted Composite Index. The industry return is the value-weighted average of all firms in the specified VL or H&Q industry.

Panel B: Hambrecht & Quist Internet-Based Firms

Portfolio Composition		Firm's Stock Only (Conv. Option)	Market-Hedged Portfolio	Industry-Hedged Portfolio	Market and Industry Hedged Portfolio
Stock or	**mean**	0.600	0.435	0.475	0.466
Benchmarked Portfolio	**median**	0.619	0.439	0.448	0.441
Alone	**stddev**	0.155	0.145	0.181	0.184
Option on Stock	**mean**	0.590	0.408	0.443	0.435
or Benchmarked Portfolio	**median**	0.609	0.420	0.427	0.421
Alone	**stddev**	0.148	0.120	0.154	0.156
Market Value of Performance-Benchmarked	**mean**	1.000	0.957	0.913	0.919
Option Relative to Conventional Option	**median**	1.000	0.971	0.956	0.961
(= w)	**stddev**	0.000	0.047	0.116	0.116
Efficiency of Option Portion of Portfolio	**mean**	0.590	0.415	0.461	0.452
When Market-Value-Equivalent Cash	**median**	0.609	0.423	0.431	0.424
Supplement of (1 - w) Paid	**stddev**	0.148	0.128	0.182	0.184
Combined Efficiency of Performance-	**mean**	0.590	0.435	0.488	0.477
Benchmarked Option Plus Market-Value-	**median**	0.609	0.441	0.457	0.450
Equivalent Cash Supplement of (1 - w)	**stddev**	0.148	0.143	0.195	0.198