Microsoft’s Employee Option Transfer Program

Don M. Chance

In recent years several companies have offered employees the opportunity to transfer out-of-the-money options to a financial institution. This paper examines a high-profile program offered by Microsoft in 2003. This program contained some complexities and had a somewhat low rate of participation. The counterparty, JPMorgan Chase, though profiting from the transfer, apparently failed to hedge the volatility risk it accepted from the employees and lost nearly the entire value it paid for the options. The experience has important implications for the design of programs that offer liquidity to, and thereby greatly change a primary characteristic of, employee stock options.

Current version, November 28, 2007

*Contact information: Department of Finance, 2163 CEBA, Louisiana State University, Baton Rouge, LA 70803, 225-578-0372, 225-578-6366 (fax), dchance@lsu.edu. This paper was presented at faculty seminars at the Louisiana State University, Auburn University, the University of Massachusetts, George Washington University, Virginia Tech, and the University of Laval and at the Northern Finance Association and Southern Finance Association meetings. The author thanks Patrick Dennis, Raman Kumar, Navroz Patel, Vijay Jog, Shiva Rajgopal, Lou Ederington, Jim Hilliard, Steve Ferris, Cliff Stephens, Chip Ryan, and Pam Peterson for helpful discussions and Tung-Hsiao Yang for research assistance.
Microsoft’s Employee Option Transfer Program

Abstract

In recent years several companies have offered employees the opportunity to transfer out-of-the-money options to a financial institution. This paper examines a high-profile program offered by Microsoft in 2003. This program contained some complexities and had a somewhat low rate of participation. The counterparty, JPMorgan Chase, though profiting from the transfer, apparently failed to hedge the volatility risk it accepted from the employees and lost nearly the entire value it paid for the options. The experience has important implications for the design of programs that offer liquidity to, and thereby greatly change a primary characteristic of, employee stock options.
Microsoft’s Employee Option Transfer Program

Perhaps the most salient feature of employee stock options is that they are essentially illiquid. Employees can capture value only through exercise of vested options. This characteristic provides the means through which employees are incentivized to remain with the company and work hard. The discount for liquidity is estimated as possibly as high as 20 percent.¹

Spurred by the significant decline in technology stocks between 1999 and 2002, many employees found themselves holding large numbers of deep out-of-the-money options. Recognizing that such options provide few incentives and contribute to low morale, some firms have undertaken programs that permit employees to transfer these options to a financial institution. By adding this element of liquidity, this feature greatly changed the nature of these options. This study examines one such program that was undertaken by Microsoft, one of the most high-profile companies in the world.

In July 2003 Microsoft announced that it was exploring an arrangement to offer employees cash to transfer certain out-of-the-money options to JPMorgan Chase (JPMC). This announcement was accompanied by a statement that Microsoft would no longer offer options, replacing them with restricted stock, and that it would retroactively expense its outstanding options, even though by accounting standards it was not yet required to do so.

The Microsoft employee option transfer program contained five important and somewhat complex features. First, each employee would be required to decide whether to tender the options before knowing how much would be offered. Second, the offer amount would be determined by inserting the average stock price over an upcoming period of fifteen trading days into an unspecified option pricing model. Third, if tendered, the maturities of most of the tendered options would be reduced. Fourth, JPMC would be selling the stock in large volume during the averaging period to comply with certain regulatory requirements and to establish a hedge. The employees assumed the risk that this selling pressure could have reduced the stock price. Fifth, an employee had to tender all options or none.

As seen in Figure 1, Microsoft’s stock had been generally falling from beginning of the year 2000, at which time it was about $60. The stock was at $27.70 on the day of the announcement. The offer applied to vested and unvested options and share appreciation rights with exercise prices of at least $33 that expire on or after February 29, 2004. Approximately 624 million options, about 40% of outstanding options and 6% of outstanding shares, held by about 37,000 of the approximately 55,000 employees of Microsoft were eligible for the program. The employees had to decide by November 12. The stock price was averaged over the period November 17 through

¹Brenner, Eldor, and Hauser (2003) compare a unique sample of traded to non-traded options in Israel and conclude that the discount for non-tradability is as much as 20 percent.
December 8, resulting in an average price of $25.572. A total of 18,503 employees (about 50%) tendered about 344.6 million options, which was about 55% of the number that could have been tendered, and received payments of about $382 million, an average of $1.11 per option. Of this total, about $218 million was paid up front with the remainder scheduled to be paid with interest over several years, subject to continued employment with the company. The tendered options represented about 22% of Microsoft’s outstanding options and about 3.3% of its outstanding shares.

Microsoft’s employee option transfer program can be viewed as a watershed event that could establish a new trend in the structure of employee options. Employees are typically required to hold their options at least until the end of a vesting period, at which time the employee can exercise them. In no cases, however, can employees sell their options. Barring the ability to synthesize a stock sale by either selling a delta-equivalent number of shares currently held or borrowed, employee options have no liquidity other than through exercise. Microsoft was not the first company to offer employees cash for their options and we take a brief look at two other, and much more successful, plans in the next section. But Microsoft was the first high-profile company to try such a plan. Interestingly, in December 2006, another high-profile company, Google, announced a similar program.

This paper is an examination of the Microsoft employee option transfer program. Following a discussion of the characteristics of the program, we examine the performance of Microsoft stock during the averaging period, review the hedging strategy employed by JPMorgan Chase during the averaging period, explore the valuation of options of this type, compare values offered with employee option values, and then examine the decision to tender all options or none. We conclude with a post-mortem analysis of the deal, proposing a reason why problems occurred in the aftermath, and the lessons to be learned for future programs.

The paper is organized in the following manner. Section I provides details of the offer. Section II provides an empirical analysis of Microsoft’s stock price behavior at critical times during the program. Section III examines the valuation of the option. Section IV contains a discussion of the results. Section V provides conclusions.

I. Background of the Microsoft Employee Option Transfer Program

Of course, Microsoft is well-known as the world’s leading provider of software. It was founded in 1975 and went public in 1981. In mid-summer 2003, its market capitalization was almost $300 billion with about 133,000 shareholders and about 10.8 billion shares outstanding. It had operations in over 70 countries, annual sales of about $32 billion, cash and cash-equivalents of about $49 billion, and net income of about $10 billion for fiscal year ending June 30, 2003.

A. Earlier Programs of Other Companies
As noted in the previous section, Microsoft was not the first company to offer its employees an opportunity to tender their options and receive cash prior to expiration. In August 2002, Siebel Systems, a Silicon Valley software firm, offered its employees a cash payment of $1.85 or stock for each option turned in. The stock was at about $8, and the options had exercise prices of $40 to $109, with an average of around $50 and an average time to expiration of a little over eight years. Employees due less than $5,000 would receive cash, and others would receive stock, half of which was unrestricted. The program was highly successful in that about 90% of eligible options were tendered by about 68% of employees. Siebels stated that the amount offered exceeded the Black-Scholes values with expiration reduced to the expected exercise date for all eligible option tranches. In almost all cases, employees would value an option at less than this adjusted Black-Scholes value, so the amounts offered appeared to exceed the values to the employee.

About a month later, Nvidia, a Silicon Valley provider of graphic chips, offered its employees the opportunity to exchange their options for stock. The offer applied to options with exercise prices ranging from $27 to $65, with an average of about $36 and an average maturity of more than seven years. Nvidia stock, which had traded as high as $71 only eight months prior, was selling for less than $9 at the time of the offer. The offer was stated as the right to tender an option and receive stock worth 3.2 times the number of shares underlying the option divided by $10.46, the closing price on October 24, 2002. Nvidia had approximately 20.6 million eligible options. The program was highly successful with 18.8 million options turned in. As with Siebels, Nvidia claimed that the offer exceeded the Black-Scholes values with appropriately reduced maturity, which would mean that the offer exceeded the values to the employees.

B. The Microsoft Agreement with JPMorgan Chase

On October 9, 2003 Microsoft entered into the agreement with JPMC for the latter to provide assistance for the employee option transfer program. JPMC would be exclusive counterparty to the options but would not be considered as providing any legal, accounting, or tax advice. The options would be converted into over-the-counter American-style options, with terms and conditions governed by the standard ISDA agreement. The transformed options were partially dividend-protected, allowing for an adjustment in exercise price at any later date if dividends were not the amounts anticipated and specified in the contract. This feature became particularly valuable to JPMC when Microsoft paid a special dividend of $3 a share in December.

---

2Because all option tranches met this criterion, Siebels was able to avoid special accounting charges. See Schwanhausser (2002) and Siebels Systems (2002) for details of the program.
3See Nvidia (2002a), Nvidia (2002b) and Nvidia (2003). As with Siebels, this assertion was made to support it not taking a special accounting charge.
4See Microsoft Corporation (2003a) for the formal agreement.
5A third party, Mellon Investor Services, was also involved for the purpose of providing the paperwork to transfer ownership of the options, and the law firms of Preston Gates & Ellis of Seattle and Davis Polk & Wardwell of New York provided legal advice.
6ISDA is the International Swaps and Derivatives Association. The standard ISDA agreement is a contract template used by ISDA members and counterparties to specify the terms of an over-the-counter derivative transaction.
2004. It is not clear whether JPMC reserved the right to sell the options to another party, but there is no such indication in the documents. JPMC’s stated intention of delta-hedging the options would suggest that it planned to hold them until expiration instead of transferring them to another party.

For providing this service, Microsoft would pay JPMC an up-front non-refundable fee of $6 million. If more than 50% of the options were tendered, an additional fee of $4 million would be earned. If more than 75% of the options were tendered, another fee of $5 million would be earned. These fees were cumulative and not mutually exclusive. Microsoft would also pay JPMC a fee of $0.02 per share for each share that the bank sold to establish a hedge, a procedure to be discussed later. This fee would amount to possibly another $12.7 million. JPMC would pay Microsoft for the options within three business days after the end of the averaging period. Terms of the agreement stipulated that JPMC would not be liable to shareholders or creditors for any matter related to the program. JPMC also retained the right of first refusal to participate if any other arrangements of this sort were undertaken by Microsoft during the next two years, although Microsoft stated that it did not expect to do this program again.7

Microsoft determined that there were no legal requirements that it ask for shareholder approval, and it did not directly inform its shareholders, although there was much publicity about the program while it was going on.

C. Terms of the Offer to Employees

Each employee would be permitted to decide until midnight November 12, 2003 whether to tender her options. A decision to tender any options applied to all options held by the employee, an important point because some options might be worth tendering while others might not. If the employee made the decision before the deadline, he could revoke the decision up until the deadline. Microsoft reserved the right to cancel the program any time up until March 24, 2004. The program was offered to employees in over 70 countries, with the exception of Belgium, Italy, and Pakistan, where legal and tax matters made the program impossible or inadvisable. The program was not available to members of the Board of Directors, thus excluding Chairman Bill Gates and CEO Steve Ballmer. The program was, however, open to non-board-member executive officers, who held about 41 million options, about 6.5% of the eligible options.

As noted earlier, the expiration dates of tendered options would be reduced. Options with expirations of more than 36 months would have their expirations reduced to 36 months. Certain options called multi-year awards, which were mostly held by high-ranking executives, would have their expirations reduced to 24 months. Most options with maturities less than 36 months would

7It is easy to see that such a designed program would probably contain a statement indicating that the company did not plan to do the program again. Otherwise, the potential for further liquidity windows in the life of the option might encourage employees to not participate until a later date.
retain their original expirations, though the multi-year awards with expirations more than 24 but less than 36 months would be reduced to 24 months. Although Microsoft would receive the funds from JPMC, it guaranteed to the employees that it could make the payments from its cash on hand. Thus, Microsoft provided a credit guarantee to JPMC. The offer applied to all options, vested and un-vested. An offer to pay cash for unvested options would theoretically contain extra value. We explore the implications of this point later.

D. Determining the Amount Offered for an Option

Microsoft stated that the option value offered to the employees would be determined “in part by reference to Black-Scholes and other option pricing models.” (Microsoft, 2003a). As noted, these options were American-style, so the reference to “other option pricing models” is most likely a reference to a binomial or finite-difference model that captures early exercise, which would be induced only by dividends. But the impact of dividends on this option is small. As we examine in more detail later, Microsoft had been paying a very low dividend and tendered options are protected against changes, further minimizing the effect of early exercise on the option value.

The amount offered for the options would be based on the average closing price from the first business day following the second calendar day after the deadline and ending 15 trading days later. Given the Thanksgiving holiday, this would define the averaging period as November 17 through December 8, though extendable as late as December 15 if trading disruptions occur, which did not happen. The averaging procedure would be based on rounding up the price to the nearest 1/10,000 of a dollar. As noted above, the computation of the option value would be performed with an attenuation of the time to expiration.

The timing of the payment to an employee was specified by a schedule. If the amount owed an employee were less than $20,000, then the employee would receive the money more or less as soon as possible after the amount owed is determined and no later than December 31, 2003. If the amount owed an employee exceeded $20,000, the employee would receive one-third of the amount by December 31. The remaining amounts would be paid with interest at the Treasury bill rate in either one or two installments, depending on the employee’s rank, by December 31, 2005 and December 31, 2006, with potentially different terms for employees of different countries. All amounts paid would be net of withholding taxes and some other unspecified fees.

A potentially important feature is that the employee would be required to maintain employment with Microsoft in order to receive these deferred payments. The more the employee is owed, the longer she would have to continue working for Microsoft to receive full payment. Thus, for some employees the program had a vesting requirement.

E. Microsoft’s Advice to Employees
Employees were given a web site from which they could determine how much they would receive, given the terms of the option and the average stock price over the upcoming averaging period. Of course, an employee would not know the average stock price before having to make the decision. Microsoft told employees that it could not guarantee a value for the options, because to do so would have meant that JPMC would have priced the options significantly lower. Microsoft stated that “The Average Closing Price that will be used in the pricing of the Stock Option Transfer Program will yield a better price per option than a significantly discounted market price would if the Average Closing Price does not fall below the significantly discounted market price” (United States Securities and Exchange Commission (2003c)). It is not clear why this statement was made, other than perhaps to avert litigation by engaging in full disclosure that the employee might have received a better deal if Microsoft had permitted JPMC to price the options with a significantly discounted, albeit known, stock price.

Interestingly, Microsoft did not make any statements to suggest that the averaging process would help the employee. Because an average price over a period of time is less volatile than the price at the end of the period, the averaging process reduces the risk from unusual price behavior near the end of the averaging period and makes it easier for the employee to forecast the value of the option.

In an email to employees at the time of the announcement, CEO Steve Ballmer (Ballmer (2003)) stated that options with exercise prices of $33 could likely be sold for about $2, with options with exercise prices of $42 worth about $0.60, and options with exercise prices of $45 valued at about $0.25. Of course, these figures were just rough estimates designed to give the employees a general idea of how much money they might receive.

The agreement entered into by Microsoft and JPMC specified that the latter would engage in sales of stock during the averaging period. Microsoft alerted employees that JPMC would sell an approximately equal number of shares each day during the averaging period and would then buy back some of these shares. It also noted that JPMC might also use derivatives, the trading of which could have some impact on the stock price. These sales would be executed for the purpose of complying with certain regulatory requirements and ultimately establishing a hedge against the bank’s acceptance of the short option positions. Microsoft heavily advised its employees that this selling pressure could result in significant declines in the price of the stock, and therefore lead to a lower average price and lower option value than might otherwise be expected.

Microsoft made clear that it was making no recommendation on whether an employee should take the offer. It advised employees that a decision should be a function of a number of factors including the outlook for the stock, the likelihood of continuing employment, the employee’s risk tolerance, the current option vesting period, the employee’s need for cash, and tax
considerations. Microsoft also identified for the employees the standard variables that affect the value of a traded option. It mentioned the Black-Scholes model but noted that the model was not entirely appropriate for non-traded options. Microsoft also provided a brief explanation of the difference between implied and historical volatility.

Microsoft requested and received a private letter ruling (PLR) from the IRS that stated that the employees would indeed be taxed on the amounts offered. Another concern, however, was the possible applicability of the Doctrine of Constructive Receipt, in which income offered but not accepted can be taxed. The PLR, however, clarified that an employee who did not choose to tender would not be taxed at that time.

F. The Impact on Microsoft

Microsoft provided a table showing the amounts it expected to pay, given various average stock prices, assuming all options were tendered. Estimates range from $313 million based on an average stock price of $22 and option value of $0.50 to almost $2 billion based on an average stock price of $32 and option value of $3.18. Microsoft estimated its overall costs at $4.5 million, not counting fees of $6 to 15 million, and $0.02 per share sold. Microsoft also paid an SEC registration fee of about $1.4 million for filing form S-3, to be discussed later. These figures suggest that total costs to Microsoft would range from $11-$33 million. Given the effectiveness of the program with about 55% of options tendered, total costs should have been around $22 million.

As noted, at the time of the announcement Microsoft stated that it would begin expensing its employee options. As a result of the transfer program, it had to accelerate the expensing of unvested tendered options, which resulted in a charge to earnings, a tax deduction, and adjustments to its deferred tax account.

G. Regulatory Approval

As Hall (2004) notes, one of the beneficial effects of Microsoft’s program is that it cleared many apparent regulatory hurdles and could open the door for further programs.\(^8\) Microsoft asked the SEC for relief from certain regulatory provisions of Rules 13-e and 14-e, which relate to tender offers. Microsoft argued that a precedent had been established in matters previously addressed by the SEC in regard to option repricing and employee stock purchase programs used by other firms that might be construed as applicable to the transfer program. The SEC provided a no-action letter on October 15, which meant that it did not object to nor would it apply these rules to the program.\(^9\) Microsoft did, however, file SEC form S-3 on September 16, which stated that JPMC would sell up to 635 million shares, some of which could be borrowed. (United States Securities

---

\(^8\)Given that Microsoft’s program was not the first, credit should perhaps be shared.  
\(^9\)See United States Securities and Exchange Commission (2003a), which includes both Microsoft’s request for relief and the SEC’s response.
and Exchange Commission (2003b)). It also filed Schedule TO on October 15, treating the program as a tender offer (United States Securities and Exchange Commission (2003c)).

H. JPMorgan Chase’s Perspective

In typical over-the-counter option deals, JPMC would buy options from a seller that might be another dealer, a corporation, or a hedge fund. Dealers and hedge funds would be fairly sophisticated investors and would be able to easily assess the value of an option. Corporations would vary in their ability to properly value these options accurately, but virtually all companies have personnel who could at a minimum arrive at a Black-Scholes value. Employees of Microsoft could, with the help of Microsoft, surely estimate Black-Scholes values conditional on an assumed average stock price but would have some difficulty assessing the values of their options, given such factors as illiquidity and vesting requirements. As in most over-the-counter trades, the dealer has an advantage in that it can trade the option at a price that buyers will pay or sellers will accept and hedge with a dynamically adjusted combination of stock, bonds, or other derivatives. The greater the information advantage, the more value that can be extracted by the dealer. From the perspective of JPMC, the program is an opportunity to use a hedge strategy to synthetically sell over-the-counter options for more than it pays. Nonetheless, JPMC bears some risk as well. Although a delta hedge is intended to be risk-free, no delta hedge is ever perfect. In addition, there are some risks faced by JPMC in setting up the delta hedge, which we shall examine.

Because of the large size of the transaction, JPMC could not sell short all of the shares at the instant at which it took title to the options. It, thus, began selling short during the averaging period and priced the offer based on the average stock price during the averaging period. Prior to the beginning of the averaging period and before the time at which it determined the number of options that would be tendered, it filed a registration statement with the SEC to sell 635 million shares, which was slightly above the maximum number that could be tendered. To establish a delta hedge, it would need to sell no more than this number of shares. In all likelihood it would sell less, perhaps far less, given that the options were deep out-of-the-money. But because of regulatory requirements, it committed to sell one share for every option tendered. Hence, it would have to oversell the stock and buy back any excess shares. The formal statements, as provided in the tender offer (United States Securities and Exchange Commission, 2003c) are as follows (these are the words of Microsoft):

JPMorgan has informed us that it intends to enter into market transactions to hedge its exposure to the ownership of the Eligible Options, as amended and restated. These market transactions will include sales of our common stock that will take place during the Averaging Period pursuant to a registration statement that we filed with the SEC.

During the Averaging Period, JPMorgan expects to sell shares of our common stock pursuant to the registration statement to establish its desired hedge
JPMorgan expects to sell approximately equal numbers of shares on each day during the Averaging Period. These sales could have the effect of decreasing the market price of our common stock. If these sales decrease the market price of our common stock during the Averaging Period, this would cause you to receive a lower price for your Eligible Options under the Stock Option Transfer Program.

During the Election Period and Averaging Periods and after the end of the Averaging Period, JPMorgan also expects to sell additional shares pursuant to the registration statement to comply with regulatory requirements. These additional shares, together with the shares JPMorgan sells to establish its desired hedge program, will equal the total number of shares underlying all Eligible Options that are transferred under the Stock Option Transfer Program. The sales of these additional shares will not be made to establish a hedge position. As a result, JPMorgan expects to purchase a number of shares in secondary market transactions approximately equal to the number of these additional shares it sells, on the same days it sells additional shares, so that JPMorgan will be in its desired hedge position after taking in account all such additional sales and purchases. The number of shares purchased may be a significant percentage of the number of shares sold under the registration statement and, depending on market factors and the terms of the transferred options, is likely to represent substantially more than half of the total number of shares sold under the registration agreement. The sales and purchases that are not made to establish JPMorgan’s hedge position may take place, before, during and after the Averaging Period.

During the Averaging Period and after the end of the Averaging Period, JPMorgan also may buy or sell additional shares of our common stock or other securities or buy or sell options or futures contracts or enter into swaps or other derivative securities in order to adjust its hedge position with respect to the Eligible Options. JPMorgan also may be active in the market for our common stock other than in connection with hedging activities in relation to the Stock Option Transfer Program. JPMorgan will make its own determination as to whether, when or in what manner any hedging or market activities in our securities will be conducted. Any of JPMorgan’s market activities with respect to our common stock may affect the market price and volatility of our common stock.

Thus, it would appear that to comply with regulatory requirements, JPMC would need to sell as many shares as options tendered, but that any excess shares would be repurchased on the same day. Ultimately it would be left with a delta-hedged position. Let us analyze JPMC’s position in setting up the hedge. First, we assume a zero interest rate, which is reasonable given the low rate of interest at that time and the very short length of the averaging period.

Let \( S_0 \) be the price at the beginning of the averaging period, \( S_\tau \) be the price at the end of the averaging period, and \( \bar{S} \) be the average stock price during the period. Although the number of options tendered was 345 million, we standardize this analysis with an assumption of one share. At the end of the period, JPMC will need \( h_\tau \) shares where \( h_\tau \) is the appropriate delta-hedge ratio at the end of the period and is based on the stock price \( S_\tau \). Of course, it does not know this stock price until after the period.

\[ h_\tau = \frac{\Delta_\tau}{\partial S_\tau} \]

10Recall that Microsoft would be paying JPMC a fee of $0.02 per share sold to establish the delta hedge. JPMC might be tempted to sell short an excessive number of shares, pocketing this fee, and hedging with a long position. This strategy would probably not cover transaction costs, however, and even if so, it would require that JPMC intentionally take advantage of one of its prime clients, which seems unlikely.
price, so it does not know this hedge ratio at the beginning of the period. We assume that it estimates that the stock price at the end of the period will be the stock price at the beginning of the period, which is probably a reasonable belief given the short length of the period. Therefore, the estimated hedge ratio is \( h_0 \), that is, conditional on \( S_0 \).

During the averaging period, it sells short \( h_0 \) shares in total, an equal number each day. At the end of the period, the cash proceeds from these sales will be \( h_0 S \). It then determines that the actual number of shares required is \( h_\tau \), which could mean that it must short more shares or that it must buy back some shares. We can express this effect by stating that it must short \( h_\tau - h_0 \) additional shares at the price \( S_\tau \). It would then be short \( h_0 + h_\tau - h_0 = h_\tau \), the proper number of shares. It will then acquire an option paying \( c(S) \) and receive an option worth \( c(S_\tau) \).

We can now determine an expression for JPMC’s position when the hedge is in place. It will have a liability of \( h_\tau S_\tau \) short shares and assets as follows,

\[
\begin{align*}
&+ h_0 S, \text{ cash proceeds received from the short sales} \\
&+ (h_\tau - h_0)S_\tau, \text{ cash proceeds (or outlay) from the final adjusting transaction} \\
&+ c(S_\tau), \text{ value of options received} \\
&- c(S), \text{ cash outlay for options.}
\end{align*}
\]

Subtracting liabilities from assets gives a net position of \( h_\tau (S - S_\tau) - (c(S) - c(S_\tau)) \). Define this expression as the gain to JPMC:

\[
G = h_\tau (S - S_\tau) - (c(S) - c(S_\tau)).
\]

In a world of perfect foresight, the initial hedge ratio \( h_0 \) would equal the final hedge ratio \( h_\tau \). In that case, the gain would be \( h_\tau (\bar{S} - S_\tau) - (c(\bar{S}) - c(S_\tau)) \), which would be a perfect delta-hedge position for an infinitesimal difference between \( \bar{S} \) and \( S \). So for a perfect hedge,

\[
h_\tau (S - S_\tau) = c(\bar{S}) - c(S_\tau),
\]

for \( \bar{S} - S_\tau \rightarrow 0 \).

The gain to JPMC can now be restated as

\[
G = h_\tau (\bar{S} - S_\tau) - h_\tau (S - S_\tau) = (\bar{S} - S_\tau)(h_0 - h_\tau).
\]

By definition, these hedge ratios are

\[
h_0 = \frac{\partial c(S_\tau)}{\partial S_0}, \quad h_\tau = \frac{\partial c(S_\tau)}{\partial S_\tau}.
\]

The change in the hedge ratio \( h_0 \) is
This expression is the option’s gamma times $dS_0$ and must equal $dh_0 = h_\tau - h_0$. Thus,
\[-dh_0 = h_0 - h_\tau = \Gamma_0(S_0 - S_\tau)\,.
\]
Hence,
\[G = (S_0 - S_\tau)(\bar{S} - S_\tau)\Gamma_0.\]

This expression provides a simple approximation of the gain or loss from the strategy to establish the hedge. Because gamma is always positive for long option positions, we see that JPMC benefits if the final price is lower than the initial price and the average price is higher than the final price, or if the final price is higher than the initial price and the average price is lower than the final price.

We can obtain an estimate of the performance of the hedge for JPMC with a Monte Carlo simulation. Reasonable random values can be generated to represent a path of stock prices from which we obtain an estimate of the average stock price, final stock price, final delta, and other values as required to determine the profitability of the strategy. One immediate problem encountered, however, is that each trial results in an average stock price that must be inserted into an American option pricing model. The most likely candidate for an American option pricing model is a binomial tree that reflects the potential for early exercise. Unfortunately, the attachment of a binomial tree to a Monte Carlo simulation creates an extremely intense and slow computational procedure. As an alternative, the very low dividend of Microsoft and the dividend protection feature of the agreement mean that the Black-Scholes model could be a reasonable proxy for an American option price. We compare Black-Scholes values with American option values obtained using a binomial tree for a range of exercise prices and expirations appropriate for these options and find a maximum difference of less than one cent in price, less than 0.06 in delta, and less than 0.0002 in gamma.\(^\text{11}\) These values are sufficiently small that we can henceforth price the options quite accurately using the Black-Scholes model.

For the simulation of JPMC’s hedging strategy, we assume that the options have an exercise price of $40 and are converted to three-year options.\(^\text{12}\) The simulation uses 100,000 trials and assumes that 344.6 million options are tendered. The results are summarized in Table I. At the beginning of the averaging period, the stock is at $25.98, the delta is 0.3011, and the gamma is

\(^{11}\)Details about the choice of volatility, time-to-expiration, dividend yield, and exercise price are provided in Section III.
\(^{12}\)These values are rounded off versions of the average strike of $38.56 and maturity of 2.9 of eligible options as reported by Microsoft.
Recall that each simulation generates an average price over the 15-day period and a final price. We observe that the average final price and the average of the average price are both within pennies of the original price. The average final price, however, has a volatility of $1.87, while the average of the average price has a much lower volatility of $1.12. The average final delta is 0.0055 higher than the original delta, and the volatility of the delta is about 0.05. As noted above, the performance of JPMC’s hedging strategy is the product of the gamma and the differences between the initial price and final price and the average price and final price. The average difference between the initial price and final price is -$0.03 and the average difference between the average price and final price is -$0.01. Hence, the average profit is positive. We see that this average profit is about $14.65 million with a standard deviation of $23.05 million.

Note that the two price differences are positive about 50% of the time and negative about 50% of the time, but the overall profit is positive over 82% of the time. Hence, the two price differences tend to be both positive or both negative at the same time. These two conditions that lead to positive profits are $S_0 > S_f$ combined with $\bar{S} > S_f$ and $S_0 < S_f$ combined with $\bar{S} < S_f$. The first condition is simply that the price falls over the averaging period and the average price is higher than the final price. The second is that the price rises over the averaging period and the average price is lower than the final price. These conditions are frequently met because a random variable with a positive drift will often have its average lie between the initial and final values.

In addition to profits from the trading strategy, JPMC would collect interest on the proceeds from the short sales, which was not factored into the above analysis. Thus, we see that, while JPMC does bear some risk, the strategy to establish the hedge would appear to have great potential. As noted above, JPMC does bear some second-order (gamma) risk, which we shall discuss later. In addition, it assumes some volatility (vega) risk, which we shall also cover later.

II. Market Activity During the Averaging Period

An important question is whether the market could absorb the intense short selling that would occur in this stock during the averaging period. Microsoft is certainly one of the most liquid of all stocks, and it is tempting to dismiss this issue, admittedly with the benefit of hindsight. But Microsoft provided extensive warnings to employees about the possible effect of JPMC’s trading on the offer price of the options. Consider the following language directed at the employees, which appeared in the tender offer (United States Securities and Exchange Commission (2003c)):

> JPMorgan has informed us that it intends to enter into market transactions to hedge its exposure to the ownership of the Eligible options, as amended. ... If these sales decrease the market price of our common stock during the Averaging Period, this would cause you to receive a lower price for your Eligible Options under the Stock Option Transfer program. ... Any of JPMorgan’s market
activities with respect to our common stock may affect the market price and volatility of our common stock. (pp. 10-11)

JPMorgan expects to sell approximately equal numbers of shares each day during the Averaging Period. These sales could have the effect of decreasing the market price of our common stock. It is possible that the Average Closing Price will be substantially below prevailing prices during the Election Period. It is also possible that prices during the Averaging Period could rise so that some Eligible Options would be in-the-money or close-to-being-in-the-money. (p. 15)

It would seem virtually impossible for employees to ignore this concern.

A. Trading Activity During the Averaging Period

As described in the previous section, during the averaging period of November 17 through December 8, JPMC was selling the stock to establish its hedge. Prior to knowing the number of options tendered, Microsoft had registered with the SEC for JPMC to sell up to 635 million shares. It committed for JPMC to sell as many shares as were tendered, which exceeds the number needed to establish the delta hedge. As noted, it stated that JPMC would buy back the excess shares the same day it sold them. At the beginning of the averaging period, JPMC knew how many shares were tendered. It committed to sell an equal number of shares each day during the averaging period to establish an approximately delta-hedged position. At the end of the averaging period, the average price would be known, which would determine the amount to be offered for the options and the delta of the options. At the end of the averaging period, JPMC would then make some final trades to fine-tune its position. As previously shown, a rough approximation of the delta of a typical out-of-the-money three-year Microsoft option would be about 0.3. Thus, JPMC would need to sell short about 103 million shares over the averaging period or about 7 million a day. Of course at the end of the averaging period it would determine the correct amount it needed and would make some residual trades to get the delta-hedged position finalized. Having committed to sell 345 million shares over the averaging period, it would therefore sell an additional 242 million shares at a rate of about 16 million a day, but it would repurchase these shares on the same day. Hence, these seemingly excess shares, sold to comply with regulations and bought back, would affect volume but would not likely affect price.

We might expect most of the buying activity to finalize the hedge to occur in the first few days of the period following the averaging period. Starting with the averaging period, we divide all other prior days in 2003 into non-overlapping 15-day periods, going back to the beginning of March, which is well past the February 18 date of a 2-for-1 stock split.

\[13\] Of course, in maintaining a delta hedge, JPMC will trade on a regular basis throughout the remaining life of the option, buying and selling shares as needed. But the number of shares bought and sold would probably not be large relative to other trading in the stock. Microsoft exchange-traded and other over-the-counter options are delta-hedged on a regular basis by options dealers. It is the large number of trades required in a short period of time to put the hedge in place that could have a significant impact on the price.
The average daily volume during the averaging period was about 87 million shares. Figure 2 shows the average daily volume for these 15-day periods. Note that the averaging period had the largest average daily volume, but there is an upward trend in volume from the period ending August 21. Note also that volume for the 15-day period following the averaging period is down substantially from the averaging period. Recall that, JPMC would be selling about 242 million shares during the averaging period to comply with regulations, but it would also buy these back. Purchases and sales would amount to about 32 million a day. It would also sell about 7 million shares daily to establish its delta hedge. Thus, an approximation of incremental daily volume is about 39 million shares. If these shares are removed, the daily average during the averaging period is about 48 million. Average daily volume for the other periods is about 61 million shares.

The days during the averaging period are well-represented in a ranking of the highest volume trading days of the year, with the year defined as the period following February 18, the split day. The averaging period represented 6.79% (15 of 221 days) of the post-split trading days of 2003. Thus, we would expect that 10*0.0679 = 0.679 days would be in the top 10, 20*0.0679 = 1.358 in the top 20, and 40*0.0679 = 2.716 in the top 40. Days during the averaging period were three of the top 10 trading days of 2003, 7 of the top 20, and 11 of the top 40. Thus, it does appear that volume is notably higher during the averaging period.14

As noted, volume is down in the post-averaging period, but this period includes the holiday season and the final days of the year, when trading is typically light. Volume during the days immediately following the averaging period was about 103 million (the 10th largest volume day of the year), 83 million, 79 million, and 69 million before dropping off sharply and averaging 61 million for the full 15-day period following the averaging period. Thus, it appears that there was a large amount of volume following the averaging period, which is likely to have come from trades by JPMC to set its delta hedge in place.

B. Stock Price Performance during the Averaging Period

Now let us examine the stock price behavior during the averaging period. Using the same set of 15-day periods, we estimate the volatility of daily returns. During the averaging period, the annualized volatility was 18.37%. Figure 3 shows the volatility of contiguous 15-day periods. Note that the averaging period had one of the lowest volatilities of all of the 15-day periods. The volatility for the two surrounding periods is quite low as well. Volatility for the period following the averaging period, which could include the effect of the aforementioned buying pressure, was only 9.21%. For the period in 2002 comparable to the averaging period, the volatility was 29.52%. While seasonality could explain some of this effect, there is certainly no indication that volatility during the averaging period was unusually high. The additional liquidity provided by JPMC

14The day with the highest volume was October 24, the day following Microsoft’s first quarter earnings announcement. The stock fell sharply from $28.91 the day before to $26.61 on 210 million shares of volume.
could have even contributed to lower volatility. In addition, buying in the period following the averaging period could also have contributed to lower volatility.

Now let us examine the performance of the stock. On November 14, the day before the averaging period began, the stock closed at 25.50. On December 8, the end of the averaging period, the stock closed at 26.24, a return over 2.9% over the averaging period. By comparison, the S&P 500 increased about 1% over that period. Figure 4.A shows the abnormal returns (ARs) for each day of the averaging period estimated with the Fama-French three-factor model. There is no indication that the ARs are uniformly positive or negative and none are statistically significant. Eight are positive and seven are negative, with the average being 0.08%. Figure 4.B shows the abnormal returns for the period following the averaging period. Note that there are large positive abnormal returns for the first two days following the averaging period. These are likely to derive from JPMC’s buying pressure. On the third day, however, the return is negative. For the full period, there are seven positive and eight negative abnormal returns with none significant.

In summary, these findings suggest that stock price performance during the averaging period was not unusual. Volume was somewhat higher, and the stock had a return of almost 3% and a relatively low volatility (compared to earlier months) of about 18%. For the period following the averaging period, the stock had a return of 4.9% and a volatility of 9.21%. It appears that the market easily absorbed the intense volume of short selling and may have even benefited from it.

III. Valuation of the Option

To value the options we need to know their characteristics. We start with the fact that eligible options had to have an exercise price of at least $33. Microsoft’s 10-K for the fiscal year ending June 30, 2003 (Microsoft Corporation (2003b) states that there were 387 million options with strikes of $33.01 to $41 and an average expiration of 3.2 years and 264 million options with strikes of $41.01 to $59.56 and an average expiration of 2.4 years. Examining the split-adjusted stock price and the 10-K’s for 1994-2004 reveals that the options had to have been issued in a fairly narrow window, between early December 1999 and mid-January 2002. Microsoft notes that most of its options were issued with seven-year maturities, which contrasts with the 10-year maturity used by most companies, and 4.5 year vesting periods. There were certainly some but probably only a few options struck above 50, because the stock price traded above 50 only for a brief period, December 1999 through March 2000. If seven-year options were granted during that period, they would have maturities of at least 3.5, which seems unlikely for a sample reported as having an average maturity of 2.4 and with no offsetting short-term options in that same strike range having been previously issued. By the time of the transfer in December, any such options

15These figures add up to 651 million options, which is slightly more than the 635 million eligible options. The difference probably represents options held by board members, who were ineligible for the program.
would have maturities of about three years and would vest in about one-half year. But since there were at least some options with these high strikes, we will examine options struck at 50 and 60 with three-year maturities, vested in 0.5 years. The lion’s share of the options is likely to be in the strike range of 33 to 45. Given when the stock was in this range, these options could have maturities of from two to five years. For options in this range, we will examine strikes of 33, 40, and 45. Considering the dates on which the stock was at these prices, representative maturities would be two and five years for the 33s, and 2.5 and 3.5 years for the 40s and 45s. The two-year options are vested, the three-year options vest in 0.5 years, and the five-year options vest in 2.5 years. For options with maturities of more than three years, offer prices are based on a reduced maturity of three years as prescribed in the agreement.

We also need risk-free rates for these time periods. Microsoft filed a document called “Call Option Transaction Confirmation with JPMorgan Chase Bank” with the SEC (Microsoft (2003c)) that states that the risk-free rate would come from the U. S. Dollar LIBOR swap curve, converted to a continuously compounded equivalent. These figures are obtained from the Federal Reserve’s data base for maturities of 2, 3, 4, and 5. For options with maturities of 2.5 and 3.5 years, we round down to the two- and three-year rates, respectively. Option valuation results are known to be not particularly sensitive to the risk-free rate.

The most critical variable in pricing an option is, of course, the volatility. Figure 5 shows the rolling 60-trading day volatility of the continuously compounded return on the stock for the last six months of 2003. Volatility averaged from 23 to 32 percent, with a sharp spike in late October, which probably corresponded to the first quarter earnings announcement that generated record trading volume. Sixty-day volatility was 30.8% on the decision day, November 12. We shall use a volatility of 30% but will also check the sensitivity of the results by examining volatilities of 25% and 35%.\(^\text{16}\)

Awash with almost $50 billion in cash, Microsoft began paying dividends in February 2003, but its dividend payment pattern has been somewhat erratic.\(^\text{17}\) We assume that the annual dividend of $0.24 paid in 2003 will be continued. Based on the stock price of $25.98 on November 12, the annual dividend is equivalent to a yield of 0.92%. We round this figure to 1%.

A. The Effect of Uncertainty in the Decision Process

As noted, the employee makes the decision by November 12, the stock is then averaged over the period November 17 through December 8, and the amount offered is determined on or

\(^{16}\)Alternative volatility estimation periods of 30- and 90-days reveals similar figures for historical volatility on November 12. Given the relative inaccessibility of historical option data bases, implied volatilities would not be easy to obtain, but it is unlikely that implied volatilities would go beyond the range we use here.

\(^{17}\)For example, Microsoft paid a dividend of $0.08 to holders of record on February 19, 2003 and one of $0.16 to holders of record on October 15, 2003. It paid its next dividend, which was $0.08, to holders of record on August 24, 2004. It then paid a dividend of $0.08 to holders of record on November 15, 2004 and supplemented that dividend with a one-time special dividend of $3.00. Of course, as noted above, JPMC had the right to adjust the strike price for dividends that do not exceed the expected dividends, which was stated to be $0.16 per year.
shortly after December 8. Thus, on November 12, the employee must estimate two values: the current value of the option to the employee and the current value of the offer. In both cases, these figures are somewhat like forward values. A decision to tender is a commitment on November 12 to exchange a standard employee option for the cash value of a standard liquid option on December 8. Such a transaction is similar in concept to the exchange option of Margrabe (1978), which provides the right but not the obligation to exchange one risky asset for another. The decision to tender is itself an option. The employee in effect holds an option granting the right to enter into an exchange forward contract, which itself is a commitment to tender one security - the employee option - and receive another – the cash value of a European option.

For example, suppose on November 12, the employee estimates the forward value of the option as $2 and the forward value of the offer as $2.50. On that basis, assume the employee tenders the option. Now assume the stock price over the averaging period is such that the amount actually offered is less than the value of the option at the end of the averaging period. The employee would then regret having tendered. Clearly tendering is not risk-free.

Let us compare this decision with a similar but simpler position, that of the holder of a more traditional call option on a forward contract. When the option expires, let the forward contract have positive value so the option would be exercised. A long forward contract would be established but might ultimately expire at a loss. When the optionholder exercises, however, he can neutralize the risk by entering into an offsetting forward contract. Barring default risk, the expiration value of the forward contract would be secured. But the forward contract underlying the option to tender the employee option is not so easily hedgeable. The employee is committed to giving up the employee option, but he holds that option so he is hedged on the outflow component of the deal. To hedge the offer, however, the employee would have to create a short position in an over-the-counter call option identical to the one he would tender or a delta-replicating short position in an exchange traded option, such as a LEAP. Moreover, these hedge options would technically have to be priced using the averaging method. These types of transaction would be essentially impossible for most employees. Hence, the decision to tender is a risky one, and the forward offer value would need to exceed the forward employee value by enough for the employee to accept the risk of tendering.

For now, we shall disregard this risk and will simply estimate the forward values of the offer and the employee option. We will address the risk later. Replicating the manner in which the employee would decide whether to tender, on November 12 we determine the offer price for December 8, conditional on information available on November 12. This procedure yields the forward offer price. We then determine the forward value of the option to the employee. On the
basis of these two values, we assume that the employee would make a decision of whether to tender or not.

B. The Effect of the Averaging Period

Options that pay off based on the average stock price over the option’s life, or a defined period of time during the option’s life, are called Asian options. These options are not easy to value. The standard lognormal diffusion so commonly assumed for modeling the return on a stock is not lognormal upon addition so that arithmetic average of a lognormal variable is not well-defined. Although a number of approximations are commonly used, probably the most popular method for pricing Asian options is Monte Carlo simulation.18 Terminal stock prices are randomly generated, the option payoff for each stock price is determined, and the average option payoff is discounted back to the present at the risk-free rate. While the Microsoft offer has some properties of an Asian option, it is not exactly a standard Asian option because the expiration payoff of the latter is a function of the average price, while the expiration payoff of the Microsoft offer is essentially an ordinary American option.

To value the Microsoft employee option offer, we employ a Monte Carlo simulation with 100,000 trials. Each trial generates a path of sequential stock prices. The average of these prices is then inserted into the Black-Scholes model.19 The overall average value is the value of the option. We do not discount this value back to the beginning of the averaging period, because the employee receives the money around the end of the averaging period or later with interest. For comparison purposes, we then find the Black-Scholes value, positioned on December 8 with various expirations for the option mentioned but using the current stock price, $25.98 on November 12. In effect, this valuation using the Black-Scholes model makes the assumption that the current stock price is an unbiased estimate of the average stock price over the short averaging period.

Table II provides these Black-Scholes and Monte Carlo values of options with the various exercise prices and expirations previously discussed and with volatilities of 25%, 30%, and 35%. Note that the averaging process has little effect on the value of the option. The Monte Carlo prices are slightly higher but never higher by more than $0.02. The averaging process has so little effect on the option price because the averaging period begins immediately and is extremely short relative to the life of the option, and because the options are deep out-of-the-money, which means that they have relatively low deltas and are, therefore, less sensitive to the stock price.

The simulated average price for the entire set of 2.5 million trials is $25.99, essentially the same as the price at the beginning of the averaging period of $25.98. Separate tests using much longer averaging periods show that the effect of the averaging period can be greater, but these

---

18 For an overview of the most popular methods for pricing Asian options, see Chapter 17 of James (2003).
19 Recall that we previously established that because of the low dividend, these American options could be valued reasonably well by the Black-Scholes model.
cases do not apply in the Microsoft transfer program. Given that the simulated values are so close to the Black-Scholes values, we can safely proceed using only the Black-Scholes values.

C. The Value of an Option to an Employee

While Microsoft would effectively offer its employees the Black-Scholes value of the option, with reduced maturity, we must determine how much value the employee would assign to the option. There is an extensive body of literature on the valuation of employee options. Typical models take into account such factors as the option’s illiquidity and any vesting period and even psychological factors. Models are found in the works of Lambert, Larcker, and Verrecchia (1991), Carpenter (1998), Detemple and Sundaresan (1999), Heath, Huddart, and Lang (1999), Meulbroek (2001), and Hall and Murphy (2002). We use the model of Hall and Murphy. This model, as described in their appendix, fits a binomial tree to the stock price so that the stock price evolves with an expected return and volatility equal to the expected return from the Capital Asset Pricing Model and the volatility that would be used in the Black-Scholes model. The employee values the option at expiration by determining the exercise value and stepping backwards through the binomial tree, exercising when the expected utility from exercise exceeds the expected utility from holding on to the option. The employee’s utility function is of the power utility form,

\[ U(W) = -\frac{W^{1-\lambda}}{\lambda}, \]

where \( W \) is the amount of wealth being evaluated and \( \lambda \) is the employee’s coefficient of relative risk aversion. Working backwards through the tree, the option value is determined as the certainty equivalent amount that, if received at time 0 and invested in risk-free bonds, would produce the same expected utility as holding the option and following the optimal exercise strategy. Exercise cannot be done at any time step prior to the vesting period. Option value will be greatest when the option makes a strong contribution to moving the employee from a non-optimal asset allocation in the direction of an optimal one. Employees with excessive (deficient) market exposure will find the option less (more) desirable and will want to exercise (hold on to) it if vested or possibly tender (hold on to) it in the presence of a transfer program.

The Hall-Murphy model requires such variables as the number of options, the employee’s non-option wealth, and the amount of the non-option wealth invested in the stock with the remainder assumed invested in risk-free bonds. It also requires an estimate of the stock’s expected return. Thus, to value the option we need option-specific information (exercise price, time to expiration, vesting period, and number of options held), stock-specific information (stock price, beta for use in the CAPM to estimate expected return, dividend yield, and volatility), and employee-specific information (risk aversion, non-option wealth, and asset allocation of non-option wealth among stock and risk-free bonds). Of course, with a binomial model we must also decide on the number of time steps.
For the option-specific information, we have already discussed the likely exercise prices, times to expiration, and vesting periods. For the number of options held, we note that there are 624 million eligible options held by about 37,000 employees, an average of 16,864 per employee. We round this figure to 15,000 but also examine holdings of 10,000 and 20,000. The stock-specific assumptions are already stated, except for the beta. Microsoft’s beta is estimated over the 60-trading day period from August 20 through November 12 and the S&P 500 as the benchmark portfolio. We obtain an estimate of 1.66. A market risk premium of 6.5% is used, as this is the estimate used by Hall and Murphy. For the employee-specific information, we assume risk aversion of 2.5 but also examine coefficients of 2.0 and 3.0. The non-option wealth figure is problematic. About 75% of Microsoft’s employees live in the Seattle area. We would also presume that most employees who receive options are relatively well-paid. Average household income in the Seattle area in 2003 was about $65,000 and the median house value was about $330,000. Of course some of this value is debt financed. But most employees would also have retirement accounts. Lacking any specific data to arrive at a more accurate estimate, we shall use $300,000 as the base figure for outside wealth and also test values of $100,000 and $500,000. The most important point is not the exact wealth but the effect of changing the wealth. For the standard case, we assume that this non-option wealth is invested in risk-free bonds at the start but also examine the cases where 20% and 50% is invested in Microsoft stock. Proceeds from early exercise are assumed to be invested in risk-free bonds.

One limitation of the analysis is termination risk. If the employee resigns or is fired, he could lose the opportunity to exercise the option. But this risk would also apply if he tenders the option. Recall that if the amount owed to an employee for a tendered option exceeds $20,000, a portion is deferred as much as three years. Although these adjustments are not likely to offset perfectly, they create a comparable risk, the net effect of which should be of secondary importance. Even if we did apply a probability of termination, such a probability does not represent a risk to which the employee is neutral; hence, an arbitrary application of a probability of termination to an option pricing model is not without some concern. Accordingly, we disregard the probability of termination.\textsuperscript{20}

\textbf{D. Comparison of Offer Values to Employee Valuations}

Table III shows the offers compared to the values assessed by the employee for the base case for the different tranches of options with three volatilities: 25\%, the benchmark 30\%, and 35\%. With each combination the offer value is lower than the employee value. With but one

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|}
\hline
Option Type & Offer Value & Employee Value \\
\hline
25\% & \$100,000 & \$110,000 \\
30\% & \$105,000 & \$115,000 \\
35\% & \$110,000 & \$120,000 \\
\hline
\end{tabular}
\caption{Comparison of Offer Values to Employee Valuations}
\end{table}

\textsuperscript{20}Technically, there is one point in which termination risk might not be offsetting. If the option’s original life exceeds three years, the employee might factor a risk of termination beyond three years into his valuation of the option, while the amount owed if the options are tendered might be so small that none of it would be deferred. We ignore this minor effect. Other than the potential for termination to eliminate any amounts owed, the simple deferral of the payments does not affect the value of the option because Microsoft will pay the employees the remaining amounts plus interest at the Treasury bill rate.
small exception, the absolute difference between the offer and the value is smaller the higher the
volatility. The reason is because of the two-way effect of volatility on an employee option. Like a
standard option, higher volatility increases the value of an employee option. But an employee
option is valued using risk preferences and not arbitrage, so higher volatility generally reduces the
value of the option. For the options examined here, option value increases with volatility, but the
effect is mitigated somewhat by the negative effect of volatility. Overall, these factors combine to
make the offer more attractive the higher the volatility.

Although all of the options are unattractive for tendering, certain ones emerge as the least
and most attractive. The options with maturities more than three years have their maturities
reduced to three years. These three options are the three least desirable options for tendering for
all volatilities. For both the 25% and 30% volatilities, the highest strike option, the 60, is the
most attractive offer, while the 45-strike, 2.5-year maturity is the second most attractive. The 50-
strike, three-year maturity is third. For the 35% volatility, however, the 33-strike, two-year
maturity is the most attractive, while the 45-strike, 2.5-year maturity is second.

Of course these conclusions are based on the benchmark case. In Tables IV and V we vary
certain inputs associated with the employee. To conserve space, we show only the difference
between the offer and the value assessed by the employee. Table IV contains two panels. Panel A
varies the number of options held from 10,000 to 15,000 (the benchmark case) to 20,000. Again,
none of the offers are sufficiently attractive for the employee to accept. The offers are more
attractive, however, the more options owned, which is due to the greater exposure to the stock.
For the case of 10,000 and 15,000 options, the most attractive offer is the 60-strike, three-year
maturity, and second is the 45-strike, 2.5-year maturity. With 20,000 options, the most attractive
is a tie between the 33-strike, two-year maturity, and the 45-strike, 2.5-year maturity, with the
former being slightly less negative when the results are carried out to more decimal places. For all
cases, the three options that have a maturity reduction are the least desirable to tender.

In Panel B of Table IV, the employee’s non-option wealth is varied. Recall that we assume
all of this wealth is invested in risk-free bonds. For the first time, we see that some offers are
attractive, and the attractiveness varies inversely with wealth. For the employee with wealth of
$100,000, almost all of the offers are attractive, though just barely. Thus, we might expect that
options tendered were likely to be tendered by employees with the least amount of external
wealth. The reason for this result is that for a given number of options, the exposure is greater
the lower the wealth, so eliminating this exposure can be justified. For wealth of $100,000, the
most attractive is the 33-strike, two-year maturity. For wealth levels of $300,000 and $500,000,
the most attractive is the 60-strike, three-maturity. In each case, the least attractive option is the
33-strike, five-year maturity. We do find one somewhat contrary result. The 40-strike, 3.5-
maturity, which suffers a reduction in maturity, is the third most attractive option for tendering for employees with $100,000 wealth, although it is seventh for the other wealth levels.

In Table V we vary the asset allocation and risk aversion. The former is the percentage of non-option wealth invested in the stock and is set at 0% for the benchmark case, but we now change it to 20% and 50% in Panel A. Note again that the more exposure the employee has to the stock, the more attractive the offer and with a sufficiently high asset allocation, all options are worth tendering. The longer maturity options take a heavy hit, but the 40-strike, 3.5-maturity option ranks low with 0% and 20% asset allocations but ranks second with a 50% asset allocation. In Panel B, we see that the results are not particularly sensitive to the degree of risk aversion. For the benchmark case, no offers are attractive for risk aversion from 2.0 to 3.0 and the rankings are similar.

In summary, the offer is more attractive if the employee has a small amount of non-option wealth, a large percentage of wealth invested in Microsoft stock, and a large number of options. These factors can be summarized by saying that the offer is more attractive the more exposure one has to the stock relative to one’s total wealth. Also, the penalty for maturity reduction is a heavy one, so it is unlikely that an employee would tender a longer-term option. Another factor affecting our conclusions, however, is the fact that the estimated differences between the offer and the value assessed by the employee are forecasts. Risk-averse employees, forced to decide about two weeks before the offer is finalized, might well have viewed any small positive expected gains as not worth the risk.

E. Who Tendered What?

In spite of the apparent unattractiveness of the offer, about half of the options were tendered. It would, of course, be interesting to obtain detailed characteristics of the options tendered and the employees who tendered, but that information is not made public. We can, however, attempt to identify the most likely options to be tendered and the most likely employees to tender. Microsoft reported that the average premium paid was $1.11 and the average strike was $38.70. The average strike suggests that there were very few high-strike options tendered, and as we noted earlier, there were likely only a few of these high-strike options outstanding.

In using the average strike and premium paid to reverse engineer and identify the likely maturity and strike of a typical option tendered, we find an unusual result. A strike of $38.70 and maturity of two years would correspond to a premium of $1.34. It would require a maturity of 1.75 years to generate a premium as low as $1.11. Yet we discussed earlier that the minimum likely maturity was two years. Thus, it appears that JPMC priced these options with volatility a lower than 30%, more like 28% to obtain these values.
Given that most options tendered appeared to be somewhat old options (around two years maturity remaining) and with strikes in the $33 to $40 range, it is likely that the employees who tendered were more experienced employees. Employees with two years or less experience are unlikely to have held many eligible options. Recall that that we found that the options were most likely tendered by employees with the highest percentage of their non-option wealth invested in Microsoft stock, employees with a large number of options, and employees with the highest risk aversion. Combining all of these factors suggests that employees who tendered were more likely to be employees with more than two years experience at Microsoft with low wealth and high exposure to the stock. These are also likely to be employees who were poorly diversified. If the program induced these employees to reduce their exposure, it likely increased their expected utility.

It is also possible that employees who tendered had private information or were pessimistic about the company's outlook. These employees were either prescient or lucky because Microsoft’s stock price, at around $27 at the time of the deal, never reached $30 over the next two years. Also, some employees could have taken the offer because of plans to leave the company. Such factors, of course, cannot be incorporated into standard valuation models, but they could explain why some employees tendered when the analysis suggests that few would have done so.

IV. Discussion

We now provide an analysis and discussion of certain qualitative aspects of the program.

A. Was the program Successful?

Recall that Microsoft offered JPMC payments of $6 million regardless of the program’s success, an additional $4 million if more than 50% of the options were tendered, and an additional $5 million if more than 75% of the options were tendered. This payment schedule suggests that Microsoft would consider a tender rate of 50% to be moderately successful and a tender rate of 75% to be highly successful. On that basis, the program would be deemed moderately successful, because 55% of the options were tendered. But this tender rate is very low in comparison to the programs of Siebel Systems and Nvidia, in which over 90% of the options were tendered. Recall that those programs were much simpler, offering employees known amounts that appeared to be much larger than the values employees would place on the options for all tranches. Another factor that contributed to the relatively low participation rate of the Microsoft program was almost surely the fact that employees had to decide whether to tender before knowing how much they would receive. In addition, employees may well have been confused about the impact of the averaging process and concerned about the possibility that the short selling of JPMC would drive down the amount offered. As previously shown, such confusion was probably unnecessary, and the averaging process probably helped the employee. The employee could have obtained a reasonable estimate of the amount to be offered by merely inserting the November 12 stock price into the
Black-Scholes model. Of course, this conclusion is drawn from a sample of only one event. Other outcomes could have had the ex post value far from the ex ante value, though the short averaging period does minimize this possibility. We also now know that the intensive short selling during the averaging period was easily absorbed by the market, so the employee need not have feared its impact, but the employee would not have known that he had little to worry about before the fact. And as noted, Microsoft gave exceptionally strong warnings to employees that JPMC’s short selling had the potential to drive the stock price down. Employees were almost surely concerned about these factors. Also, the all-or-nothing requirement probably reduced the participation rate.

B. The Requirement to Tender All Options or None

In this section we examine three possible reasons why Microsoft may have chosen the all-or-nothing plan. The first is that it might have believed that employees would find that the options they hold with positive gains to tendering more than offset those with negative gains to tendering. The second is that the employees might have been unable to determine the gains from tendering but would have chosen to tender over not tendering. The third is that the all-or-none requirement might have been easier from an administrative standpoint.

Oftentimes an all-or-none requirement is used because of the adverse selection problem. It might appear that an employee could tender the options that were advantageous to tender and retain those that were advantageous to retain, leaving a counterparty at a disadvantage. Let us consider the possible ways the program could have been designed with the adverse selection problem in mind. Assume that there are only two tranches of options, tranche A and tranche B and only one employee who holds one of each tranche. The company considers two programs, Plan 1 permitting the employee to tender either or both options, or Plan 2 requiring the employee to tender both or none. Assume that the values of the options to the employee are $V_A$ and $V_B$ and that the offer price is $O_A$ and $O_B$, respectively. We ignore any uncertainty in the offer price or value for now.

Now consider why the company created the program. The company and the employees felt that the options did not provide much incentive. Thus, we assume that the incentive provided by an option is small but non-zero. If the employee holds on to an option, the incentive is retained. If the employee tenders the option, the incentive is destroyed. Thus, tendering is costly to the company but this cost is clearly very small inasmuch as the options have already been deemed to provide very little incentive.

Table VI summarizes the possible outcomes, optimal employee actions and the implications for the employee and Microsoft under the two alternative structures. Under Plan 1 the employee tenders only the options that are worth tendering, while under Plan 2 the employee could find it
worthwhile to tender options not worth tendering if the options worth tendering provide gains that more than offset the losses from the options not worth tendering.

There are six conditions represented by the rows. In the first and fourth, the effect on Microsoft is the same under both plans. In the second condition, the marginal impact of the restriction of Plan 2 is the loss of incentive on option B. In the third outcome, Microsoft retains the incentive on option A. In the fifth outcome, the marginal impact of Plan 2 is that Microsoft loses the incentive on option A. In the sixth outcome, the marginal impact is retention of the incentive on option B. Thus, under two of the outcomes, Microsoft would prefer Plan 1, under two it would prefer Plan 2, and under two it would be indifferent. If the outcomes are equally likely, there is no clear preference for either plan. But taking into account the fact that Microsoft is offering the program because it believes the options do not provide much incentive, the cost from the loss of incentives must be very low. The only justification for Plan 2 would be retention of incentives, which it admits are worth very little. Considering the fact that Microsoft would seem to want a high degree of participation, Plan 2 does not appear to be the better alternative.

Moreover, Plan 2 has a greater degree of uncertainty of the number of options tendered. Under both plans, the expected number of options tendered is the same at 1. But the standard deviation of the number of options tendered is 0.58 under Plan 1 and 1.00 under Plan 2. So, while Microsoft would expect the same number of options to be tendered under both plans, there is about 70% more uncertainty of the number of tendered options with the all-or-nothing plan.

The above analysis assumes that employees can assess the values of the options and the amounts offered. Now let us assume that there is uncertainty in the assessed values, as in the real case. With the all-or-nothing plan, Microsoft must believe that an employee would be more inclined to tender than not in the presence of uncertainty. Consider a risk-averse employee facing such a decision. If the employee does not tender, his wealth position will be unaffected. If the employee tenders, his wealth will either increase or decrease. Without strong priors pointing to a greater likelihood of a wealth increase from tendering, any risk-averse employee would probably be inclined to not tender.

One final reason Microsoft might have offered the all-or-nothing plan is administrative ease. It is quite possible that it was much easier and less costly to implement the plan on an employee basis rather than on an option-tranche basis. Consider that records of employee options have two dimensions: the option characteristics and the employees. Because not all option tranches would be tendered under any plan, Microsoft would still have multiple option tranches outstanding regardless of how it structures the plan. But under the all-or-none rule, Microsoft would be able to eliminate the administrative costs of having any options owned by a given employee. There could be some savings in this case. While we cannot thoroughly analyze this
factor, we should not discount the potential role it could have played in Microsoft’s decision. But
the all-or-nothing requirement probably reduced the tender rate.

C. Public Commentary and Criticism of the Program

Microsoft was criticized for the program, most notably by renowned compensation expert
Graef Crystal, who wrote articles in July and October (Crystal 2003a, 2003b) in Bloomberg News. In the
first article, Crystal estimated the values of some representative options using the Black-
Scholes model and noted that the employees would receive considerably less than these values
based on preliminary figures mentioned in the email by Steve Ballmer announcing the program.
Crystal also compared the offer to the values of traded options. Unaware at that time that some
offers would be even lower due to the reduction in maturity, Crystal argued that the program was
not a good deal for employees. He subsequently learned that the option maturities would be
shortened and went on in a second article to chastise Microsoft and make extremely derisive
comments about employees who turn in their options. For example:

... it seems likely this offer may be best used as a ‘selection’ device: an employee who
turns in his options is fired for stupidity and someone else with more brains is hired. At
the least, one casualty of the offer could well be productivity, as employees turn their
attention away from designing world-class software. (Crystal, 2003b).

Crystal also criticized both Microsoft and JPMC for not providing much information to him and
the general public, stating that “Microsoft deflected my questions for details at the time by
advising me to call JPMC. And JPMC in turn dived to 600 feet and maintained strict radio
silence.” (Crystal 2003b). In fact Microsoft provided an extensive amount of information on this
program, most of which was available on the Internet.

It should be noted that in an article published around the end of the averaging period,
Crystal (2003c) changed his tune, praising JPMC for doing “something socially responsible and
useful, while also making a profit.” Crystal also notes the educational value of the program in
proving to employees that even deep out-of-the-money options have value.

D. Implications for Future Programs

Hall (2004) praises the Microsoft program as opening the door to a new concept in
employee compensation and incentives in the form of transferable options. He notes that these
options are quite advantageous in terms of simplifying valuation, maintaining incentives, providing
transparency, and introducing competitive pricing in the form of third-party valuation. Let us
consider the implications of a company offering a transferable stock option program.
The Microsoft options were not transferable when first offered.\textsuperscript{21} Thus, employees, shareholders, and perhaps even Microsoft itself would not have viewed these options as transferable until the program was announced. It is not clear how the potential for random transferability would affect an option’s value. Suppose that the company stated up front that the options would become transferable as of a certain date. Valuation would still be complex, because the employee and issuer would need to account for the potential that an employee would tender the options. While it would appear that employees would always prefer transferable options, if there is maturity reduction penalty the choice is not as obvious. There are a myriad of complex issues and ways in which transferable options could be designed. If the employee is unable to make an informed decision, it is not clear that transferable options are better for employees.

In the fall of 2004 JPMC conducted a similar program for 63,000 non-Comcast employees who held about 42 million Comcast options awarded when Comcast acquired AT&T Broadband in 2002. The options had a Black-Scholes value of about $125 million. Since these were not employees of Comcast, their holdings of Comcast options did not provide incentives and resulted in administrative costs, while still being illiquid. Only about 11 million options were tendered for a total payment of about $37 million. (Comcast (2004a, 2004b)). In December 2006 Google announced an employee option transfer program in which employees could offer their options to the highest bidder from among interested financial institutions (Jung (2007)). The maturities would be reduced to a maximum of two years. Morgan Stanley and Smith Barney will conduct the program.

In 2003 JPMC was reported to have applied for a patent on the program to protect what it felt was its intellectual property (Crystal (2003c), but this action might have been premature. The bank soon found that the program created a problem it had not anticipated.

\textbf{E. The Aftermath}

On September 1, 2005 Reuters News Wire (2005) reported that JPMC was selling the options it had acquired from Microsoft due to large losses that may have begun shortly after the deal was completed. Reuters reported anecdotal estimates of JPMC’s losses at anywhere from $100 to $450. The upper range seems unlikely given that the options were acquired for only $382 million. But it is not difficult to determine why large losses were incurred. JPMC evidently failed to consider volatility risk.\textsuperscript{22}

\textsuperscript{21}Microsoft may have hinted at this program as early as 2001, because the proxy statement for its 2001 stock option plan states the following: “An Award may not be sold, pledged, assigned, hypothecated, transferred, or disposed of in any manner other than by will or by the laws of descent or distribution and may be exercised, during the lifetime of the Awardee, only by the Awardee; provided that the Board may permit further transferability, on a general or specific basis, and may impose conditions and limitations on any permitted transferability. (italics added) See Microsoft (2001).

\textsuperscript{22}See Patel (2005) for a practitioner discussion of the events following the completion of the deal.
Figure 6 shows the rolling annualized 60-day volatility of Microsoft from early December 2003 through early December 2005. The reduction is remarkable, from around 30% at the time of the deal to about 15%, a level reached as early as the first quarter after the deal was completed. The offer prices estimated in Table III for 30% volatility for the different tranches were $2.34, $3.49, $1.61, $2.13, $1.07, $1.50, $1.07, and $0.55. The respective vegas are 13.78, 17.34, 13.32, 15.64, 11.12, 13.72, 11.69, and 8.03. A simple calculation reveals that a 15% reduction in volatility would destroy somewhere between 70 and 100 percent of option value. Similar results are confirmed by using exact recalculations with the 15% volatility. With the hedge executed with short sales of Microsoft stock, there is no offsetting vega from the hedge instrument. So unless JPMC hedged the volatility using a volatility derivative, it likely lost nearly all of the value of the options. Of course, that value could return at a later date if the stock volatility increases.

As noted earlier, employee options have less volatility risk than traded options. By converting employee options into traded options, a considerable amount of volatility risk was created and assumed by JPMC. Employees who tendered, of course, shed all of the risk. Even employees who did not tender did not bear much risk. Consider the employee option values in Table III at a volatility of 30%. It is possible to use the aforementioned employee option valuation model to estimate an average vega from the employee’s perspective. These estimates produced vegas of between 2.5 and 7, with an average of 5.56, considerably lower than the average vega of the options assumed by JPMC of about 13.08. Thus, the employees who did not tender had volatility risk of less than half the volatility risk assumed by JPMC, and the employees who did tender eliminated this risk, turning it into much greater risk for JPMC.

V. Summary and Conclusions

The Microsoft employee option transfer program was more complex and far less successful than similar programs. Employees faced uncertainty over the offer amount, concern over how the offer would be determined, and fear of the impact of short selling while the hedge is established. Ultimately short selling did not have a noticeable effect on the stock, but employees would not have known this at the start, and Microsoft gave very explicit warnings about this risk. After the fact it would have been straightforward to determine the offer amount, but this would not have been obvious before the fact. Given the choice of holding on to their options and being no worse off, or tendering and either being better off or worse off, risk aversion would dictate that most employees would choose not to tender. Another factor that almost surely contributed to the somewhat low tender rate was the fact that an employee had to tender all options or none. There seems to be no obvious economic reason for such a requirement, and it is possible that it might have been for administrative ease. For whatever reason, it was probably a costly one. Overall the findings suggest that employees who tendered were likely those with the most seniority and
exposure to Microsoft stock either from stock or other options. Intention of leaving the firm could have also motivated some employees to tender.

JPMorgan Chase received approximately $22 million from Microsoft and probably generated some additional profits from the transactions that set up its hedge. We also find that it probably priced the options with volatility slightly lower than the current volatility. Nonetheless, it assumed considerable volatility risk, failed to hedge that risk, and lost nearly all of the value of the options. In fact, from this outcome we see that such programs in general result in a significant transfer of volatility risk from employees to the financial institution.

There has been considerable interest in recent years in addressing the problem of how illiquidity of employee stock options affects their values. In 2005 Cisco proposed an auction process for a marketable employee stock option but the plan was opposed by the SEC, though a similar plan proposed by Zions Bancorporation was approved in 2007 (Mazumdar et al (2007)). Efforts to address the liquidity problem of employee stock options are likely to continue and should benefit from the Microsoft experience. Employees holding stock options are rational investors, like everyone else. Employee option transfer programs should be viewed like well-functioning financial markets. Participation is discouraged if transaction costs and search costs are high. Where confusion and uncertainty are high, employees will demand substantial risk premia to participate. Financial institutions that purchase these options must properly assess and manage the risk they assume.
Table I
Monte Carlo Simulation of Hedge Establishment Strategy

The simulation is based on the assumption that 344.6 million options are tendered, the options all have an exercise price of $40 and an expiration, which has been contractually shortened, of three years. The volatility is 30%. The averaging period is 15 trading days and 21 calendar days. The stock price at the beginning of the averaging period is $25.98, and the dividend yield is 1%. The risk-free rate for the three-year options is 2.31%, the continuously compounded equivalent of the three-year U. S. dollar swap rate. Interest is ignored during the averaging period. The number of simulation runs is 100,000.

<table>
<thead>
<tr>
<th></th>
<th>Average</th>
<th>Standard Deviation</th>
<th>95% low</th>
<th>95% high</th>
<th>% &gt; 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final stock price ($S_\tau$)</td>
<td>$26.01</td>
<td>$1.87</td>
<td>$22.26</td>
<td>$29.75</td>
<td></td>
</tr>
<tr>
<td>Average stock price ($\bar{S}$)</td>
<td>$25.99</td>
<td>$1.12</td>
<td>$23.75</td>
<td>$28.23</td>
<td></td>
</tr>
<tr>
<td>Final delta ($h_\tau$)</td>
<td>0.3066</td>
<td>0.0474</td>
<td>0.2119</td>
<td>0.4013</td>
<td></td>
</tr>
<tr>
<td>(S_0 - S_\tau)</td>
<td>-$0.03</td>
<td>$1.87</td>
<td>-$3.77</td>
<td>$3.72</td>
<td>50.74%</td>
</tr>
<tr>
<td>(\bar{S} - S_\tau)</td>
<td>-$0.01</td>
<td>$1.04</td>
<td>-$2.09</td>
<td>$2.06</td>
<td>50.77%</td>
</tr>
<tr>
<td>Profit/Loss from hedging strategy</td>
<td>$14.65</td>
<td>$23.05</td>
<td>-$31.45</td>
<td>$60.76</td>
<td>82.55%</td>
</tr>
</tbody>
</table>
Table II
Black-Scholes and Monte Carlo Values of the Microsoft Employee Option Offers

Prices are computed for options using the Black-Scholes model and a Monte Carlo simulation that takes into account the averaging period that precedes the date on which the option value will be determined. The average price over the 15 trading-day period of November 17, 2003 through December 8, 2003 is determined and inserted into the Black-Scholes model. A total of 100,000 simulations are performed. The Black-Scholes price shown is computed in the standard manner, positioned on December 8 with a stock price of $25.98. The stock price on November 17 is $25.98, the exercise prices, volatilities, and times to expiration are as shown below, the risk-free rates are maturity-matched continuously compounded yields from the U.S. dollar swaps market, interpolated where necessary, and the dividend yield is 1%. The average simulated price over all 2.5 million trials is $25.99 (the actual price average price was $25.572). *Indicates that the maturity is longer than three years and according to the terms of the buyout offer, the maturity is reduced to three years.

<table>
<thead>
<tr>
<th>Strike/Maturity</th>
<th>Volatility = 25%</th>
<th>Volatility = 30%</th>
<th>Volatility = 35%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Black-Scholes</td>
<td>Monte Carlo</td>
<td>Black-Scholes</td>
</tr>
<tr>
<td>33/2</td>
<td>1.67</td>
<td>1.68</td>
<td>2.34</td>
</tr>
<tr>
<td>33/5*</td>
<td>2.63</td>
<td>2.64</td>
<td>3.49</td>
</tr>
<tr>
<td>40/2.5</td>
<td>0.99</td>
<td>1.00</td>
<td>1.61</td>
</tr>
<tr>
<td>40/3.5*</td>
<td>1.38</td>
<td>1.39</td>
<td>2.13</td>
</tr>
<tr>
<td>45/2.5</td>
<td>0.57</td>
<td>0.58</td>
<td>1.07</td>
</tr>
<tr>
<td>45/3.5*</td>
<td>0.87</td>
<td>0.88</td>
<td>1.50</td>
</tr>
<tr>
<td>50/3</td>
<td>0.55</td>
<td>0.56</td>
<td>1.07</td>
</tr>
<tr>
<td>60/3</td>
<td>0.22</td>
<td>0.23</td>
<td>0.55</td>
</tr>
</tbody>
</table>
Table III
Offer Values and Expected Utility Values of the Microsoft Employee Options

Prices are computed for options using the Black-Scholes model as the amount offered and an expected utility model that takes into account the option holder’s risk aversion, holdings, and wealth along with various other relevant factors in determining employee value. The stock price is $25.98, the exercise price, maturity, and time to vest are shown below, the risk-free rates are maturity-matched continuously compounded yields from the U. S. dollar swaps market interpolated where necessary, the volatility is shown below, and the dividend yield is 1%. The number of options is 15,000, the Microsoft beta is 1.66, the option holder has non-option wealth of $300,000 allocated completely to risk-free bonds at the start, and the option holder’s risk aversion is 2.5. The market risk premium is 6.5%, and exercise proceeds are placed into risk-free bonds. The expected utility model is a binomial model that uses one time step per month and will exercise the option early if the expected utility from exercise exceeds the expected utility from holding the option. *Indicates that the maturity is longer than three years and according to the terms of the buyout offer, the maturity is reduced to three years for purposes of estimating the buyout offer.

<table>
<thead>
<tr>
<th>Strike/Maturity/ Years to vest</th>
<th>Volatility = 25%</th>
<th>Volatility = 30%</th>
<th>Volatility = 35%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Offer</td>
<td>Value</td>
<td>Diff</td>
</tr>
<tr>
<td>33/2/0</td>
<td>1.67</td>
<td>2.50</td>
<td>-0.83</td>
</tr>
<tr>
<td>33/5*/2.5</td>
<td>2.63</td>
<td>7.13</td>
<td>-4.50</td>
</tr>
<tr>
<td>40/2.5/0</td>
<td>0.99</td>
<td>1.75</td>
<td>-0.76</td>
</tr>
<tr>
<td>40/3.5*/1</td>
<td>1.38</td>
<td>2.94</td>
<td>-1.56</td>
</tr>
<tr>
<td>45/2.5/0</td>
<td>0.57</td>
<td>1.13</td>
<td>-0.56</td>
</tr>
<tr>
<td>45/3.5*/1</td>
<td>0.87</td>
<td>2.18</td>
<td>-1.31</td>
</tr>
<tr>
<td>50/3/0.5</td>
<td>0.55</td>
<td>1.16</td>
<td>-0.61</td>
</tr>
<tr>
<td>60/3/0.5</td>
<td>0.22</td>
<td>0.53</td>
<td>-0.31</td>
</tr>
</tbody>
</table>
Table IV
Difference between Offer Values and Expected Utility Values of the Microsoft Employee Options by Options Held and Non-Option Wealth

Prices are computed for options using the Black-Scholes model as the amount offered and an expected utility model that takes into account the option holder’s risk aversion, holdings, and wealth along with various other relevant factors in determining the employee value. The number in each cell is the difference between the Black-Scholes value and the employee option value and, thus, represents the gain or loss to the employee from tendering. The stock price is $25.98, the exercise price, maturity, and time to vest are shown below, the risk-free rates are maturity-matched continuously compounded yields from the U. S. dollar swaps market interpolated where necessary, the volatility is 30%, and the dividend yield is 1%. The Microsoft beta is 1.66, wealth is allocated completely to risk-free bonds at the start, and the option holder’s risk aversion is 2.5. The market risk premium is 6.5%, and exercise proceeds are placed into risk-free bonds. In Section A, the non-option wealth is $300,000, and the number of options varies as shown. In Section B, the number of options is 15,000, and the non-option wealth varies as shown. The expected utility model is a binomial model that uses one time step per month and will exercise the option early if the expected utility from exercise exceeds the expected utility from holding the option. *Indicates that the maturity is longer than three years and according to the terms of the buyout offer, the maturity is reduced to three years.

<table>
<thead>
<tr>
<th>Strike/Maturity/Years to vest</th>
<th>A. Number of Options Held</th>
<th>B. Non-option Wealth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10,000</td>
<td>15,000</td>
</tr>
<tr>
<td>33/2/0</td>
<td>-0.84</td>
<td>-0.47</td>
</tr>
<tr>
<td>33/5*/2.5</td>
<td>-4.33</td>
<td>-3.13</td>
</tr>
<tr>
<td>40/2.5/0</td>
<td>-0.84</td>
<td>-0.50</td>
</tr>
<tr>
<td>40/3.5*/1</td>
<td>-1.61</td>
<td>-1.06</td>
</tr>
<tr>
<td>45/2.5/0</td>
<td>-0.62</td>
<td>-0.37</td>
</tr>
<tr>
<td>45/3.5*/1</td>
<td>-1.49</td>
<td>-1.03</td>
</tr>
<tr>
<td>50/3/0.5</td>
<td>-0.74</td>
<td>-0.46</td>
</tr>
<tr>
<td>60/3/0.5</td>
<td>-0.49</td>
<td>-0.33</td>
</tr>
</tbody>
</table>
Prices are computed for options using the Black-Scholes model as the amount offered and an expected utility model that takes into account the option holder’s risk aversion, holdings, and wealth along with various other relevant factors in determining the employee value. The number in each cell is the difference between the Black-Scholes value and the employee option value and, thus, represents the gain or loss to the employee from tendering. The stock price is $25.98, the exercise price, maturity, and time to vest are shown below, the risk-free rates are maturity-matched continuously compounded yields from the U. S. dollar swaps market interpolated where necessary, the volatility is 30%, and the dividend yield is 1%. The Microsoft beta is 1.66, the number of options held is 15,000, and the non-option wealth is $300,000. The market risk premium is 6.5%, and exercise proceeds are placed into risk-free bonds. In Section A, the risk aversion is 2.5 and the asset allocation varies as shown. In Section B, the asset allocation is 0% in stock, and the risk aversion varies as shown. The expected utility model is a binomial model that uses one time step per month and will exercise the option early if the expected utility from exercise exceeds the expected utility from holding the option. *Indicates that the maturity is longer than three years and according to the terms of the buyout offer, the maturity is reduced to three years.

<table>
<thead>
<tr>
<th>Strike/Maturity/ Years to vest</th>
<th>A. Asset Allocation (percentage in stock)</th>
<th>B. Risk Aversion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0%</td>
<td>20%</td>
</tr>
<tr>
<td>33/2/0</td>
<td>-0.47</td>
<td>0.15</td>
</tr>
<tr>
<td>33/5*/2.5</td>
<td>-3.13</td>
<td>-0.33</td>
</tr>
<tr>
<td>40/2.5/0</td>
<td>-0.50</td>
<td>0.11</td>
</tr>
<tr>
<td>40/3.5*/1</td>
<td>-1.06</td>
<td>-0.11</td>
</tr>
<tr>
<td>45/2.5/0</td>
<td>-0.37</td>
<td>0.10</td>
</tr>
<tr>
<td>45/3.5*/1</td>
<td>-1.03</td>
<td>-0.19</td>
</tr>
<tr>
<td>50/3/0.5</td>
<td>-0.46</td>
<td>0.09</td>
</tr>
<tr>
<td>60/3/0.5</td>
<td>-0.33</td>
<td>-0.04</td>
</tr>
</tbody>
</table>
Table VI
Comparison of the Microsoft Employee Options
Under Tendering any or all Options Compared to Tendering all or no Options

The table below assumes that there is a single employee and two tranches of options, tranche A and tranche B, with the employee holding one of each tranche. The values of the two options to the employee are $V_A$ and $V_B$, and the amounts offered are $O_A$ and $O_B$. We assume no uncertainty with respect to these amounts. Plan 1 allows the employee to tender either or both options, and Plan 2 requires that the employee tender both or none. It is assumed that if an employee tenders an option, Microsoft loses the incentives, although these incentives are small because the options are deep out-of-the-money.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Plan 1 (tender either or both)</th>
<th>Plan 2 (tender both or none)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$O_A &gt; V_A$ &amp; $O_B &gt; V_B$</td>
<td>Tender A &amp; B</td>
<td>$O_A - V_A + O_B - V_B &gt; 0$</td>
</tr>
<tr>
<td>$O_A &gt; V_A$ &amp; $O_B \leq V_B$ &amp; $O_A + O_B &gt; V_A + V_B$</td>
<td>Tender A</td>
<td>$O_A - V_A &gt; 0$</td>
</tr>
<tr>
<td>$O_B &gt; V_B$ &amp; $O_A \leq V_A$ &amp; $O_A + O_B \leq V_A + V_B$</td>
<td>Tender A</td>
<td>$O_A - V_A &gt; 0$</td>
</tr>
<tr>
<td>$O_A &lt; V_A$ &amp; $O_B &lt; V_B$</td>
<td>Do not tender</td>
<td>No effect</td>
</tr>
<tr>
<td>$O_B &gt; V_B$ &amp; $O_A \leq V_A$ &amp; $O_A + O_B &gt; V_B + V_A$</td>
<td>Tender B</td>
<td>$O_B - V_B &gt; 0$</td>
</tr>
<tr>
<td>$O_B &gt; V_B$ &amp; $O_A \leq V_A$ &amp; $O_B + O_A \leq V_B + V_A$</td>
<td>Tender B</td>
<td>$O_B - V_B &gt; 0$</td>
</tr>
</tbody>
</table>
Figure 2. Average daily volume over contiguous 15-day periods during 2003. The earliest period starts shortly after February 18 on which there was a stock split.
Figure 3. Volatility over contiguous 15-day periods in 2003. The earliest period starts shortly the February 18 stock split. Volatility is the annualized standard deviation of the log return without dividends.
Figure 4.A. Abnormal returns for the 15-day averaging period, November 17 through December 8. Abnormal performance is estimated using a Fama-French three factor model with sensitivities estimated over the period June 21, 2002 through June 20, 2003.

Figure 4.B. Abnormal returns for the 15-day period following the averaging period, December 9 through December 30. Abnormal performance is estimated using a Fama-French three factor model with sensitivities estimated over the period June 21, 2002 through June 20, 2003.
Figure 5. Rolling annualized 60-day volatility of Microsoft stock for the second half of 2003. Volatility is the annualized standard deviation of the log return estimated using a 60-day rolling window.
Figure 6. Rolling annualized volatility of Microsoft stock for two years after the transfer. Volatility is the annualized standard deviation of the log return estimated using a 60-day rolling window.
References


Comcast, 2004a, Comcast Corporation to conduct one-time stock option liquidity program for non-employee holders of Comcast stock options, press release, September 21.


Crystal, Graef, 2003b, Microsoft option offer is no deal for employees, *Bloomberg News*, October 22.


Microsoft Corporation, 2003a, Program agreement between Microsoft Corporation and JPMorgan Chase Bank relating to the stock option transfer program of Microsoft Corporation, October 9. www.sec.gov/Archives/edgar/data/789019/000119312503062134/dex99d3.htm


Reuters, 2005, Fees now, trouble later, September 1.


United States Securities and Exchange Commission, 2003c, Microsoft Corporation notice to eligible employees of stock option transfer program, October 15. www.sec.gov/Archives/edgar/data/789019/0000119312503062134/dex99a1.htm