An Empirical Comparison of Hedging Strategies with Financial Futures and Options on Futures

Ramin Cooper Maysami

ABSTRACT

Hedging fixed rate mortgage (FRM) portfolios with financial futures and options is suggested to substitutes for the adjustable rate mortgage as the hedging instrument. This study examines the comparative benefits of hedging the FRM through selling futures, buying puts, and the combined buy-put/sell-call strategies in lowering the standard deviation of returns of the unhedged portfolio over the period 1983 to 1991. The results show that covering the FRM through futures and options markets strategies are successful in lowering the variability of returns. The relative advantage of each strategy in terms of the mean-standard deviation pairs, however, depends on the direction of interest rate movements. Since the primary purpose of financial institutions in hedging interest rate risk associated with their portfolio of fixed rate mortgages is to prevent values from falling as well as to reduce the variability of returns, the use of put options and financial futures as the hedging instrument is recomended.

ABSTRAK

*Melindung nilai portfolio-portfolio gadai janji berkadar tetap (FRM) dengan menggunakan niagaan ke depan kewangan dan opsyen telah dicadangkan bagi menggantikan penggunaan gadai janji berkadar berubah sebagai suatu instrumen untuk melindung nilai. Kajian ini meneliti kelebihan melindung nilai FRM dengan cara menjual niagaan ke depan, membeli **Put** dan secara gabungan strategi beli **Put**/jual panggil dalam mengurangkan sisihan piawai bagi pulangan portfolio yang tidak dilindung nilai untuk tempoh 1983 hingga 1991. Penemuan kajian menunjukkan bahawa melindung nilai FRM dengan menggunakan strategi pasaran niagaan ke depan dan opsyen berjaya mengurangkan kebolehan ubahan (risiko) pulangan. Kebaikan secara relatif bagi setiap strategi dari segi pasangan sisihan piawai dan min, walau bagaimanapun, bergantung kepada arah pergerakan kadar faedah. Oleh sebab tujuan asal institusi kewangan dalam melindung nilai risiko kadar faedah yang berkaitan dengan portfolio FRM mereka ialah untuk menghalang nilai daripada jatuh dan juga untuk mengurangkan kebolehan pulangan, maka penggunaan opsyen **Put** dan nigaan ke depan kewangan adalah diperakukan sebagai instrumen untuk melindung nilai.*

INTRODUCTION

Managing interest rate risk associated with holding a portfolio offixed rate mortgages has been a continuously troublesome task for mortgage holding institutions. With a general increase in the levels of interest rates, savings institutions must pay higher rates of interest on their deposits while continuing to receive constant rates on their long term loans. As a result, such institutions whose deposits are mainly short-term will would see a decline in profitability if their assets are primarily long-term fixed mortgages.

Interest rate risk to the mortgage banker is synonymous with the price risk--the potential change in the value of the mortgage product because of future changes in its sale price[1]. If the bank tried to liquidate its long-term loans by selling them, capital losses would result since it owned a long term asset that earned below market rate of interest. Investors would not be willing to pay face value for such a loan. The institution looses whether it chose to keep the loan or to sell it.

The introduction of the first generation variable-rate mortgages in 1981, and the more advanced adjustable rate mortgages (ARMs) in the subsequent years, allowed such institutions to better match the maturities of their assets and liabilities and attempt to deal with a yield curve that shifts up or down. The investors in mortgage funds have relied heavily on adjustable rate mortgages as a tool of controlling the interest rate risk of their mortgage portfolios (Figure Ia). However, when using ARMs as a hedging instrument, they could not at the same time benefit from lower interest rates as when they owned fixed rate mortgages. As market rates declined, the value of the asset would not appreciate since mortgage rates were also adjusted downward. ARMs eliminated the possibilities of capital losses as well as the gains (Figure Ib).

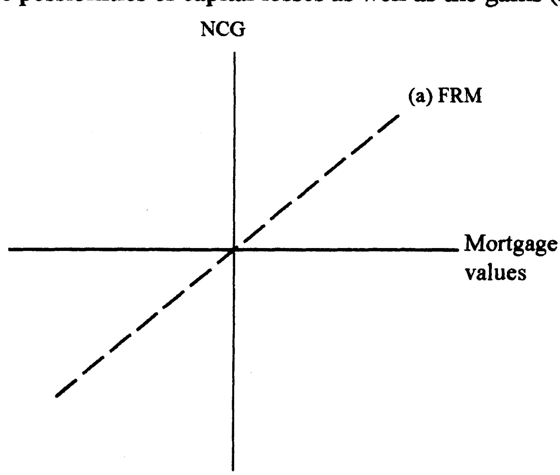

FIGURE Ia. Net capital gain from change in the valuue of the mortgage a. portfolio: Fixed rate mortgage

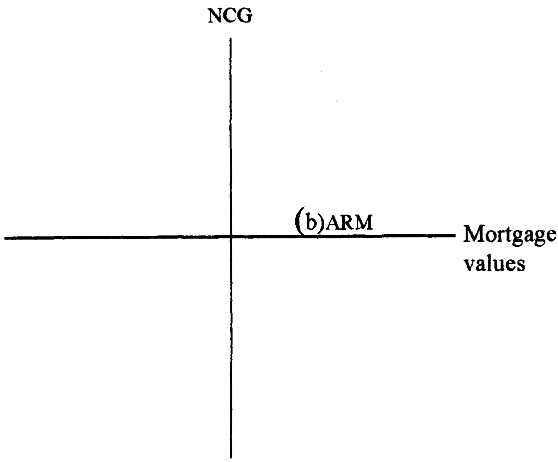

FIGURE Ib. Net capital gain from change in the valuue of the mortgage:
b. Adjustable rate mortgage

The current study aims to integrate various theoretical suggestions for hedging mortgages with financial futures and options in order to empirically test selected hedging strategies over the period 1983 to 1991. The hedging strategies chosen are to cover the FRM portfolio by selling futures contracts on Treasury bonds, through purchasing put options on the futures contracts, or with the use of a combined strategy of buying puts and selling call options on such contracts.

These strategies are selected primarily for illustrative purposes in developing a general method which may be followed in future studies to derive return distributions to a mortgage portfolio hedged with other strategies, as well as with other types of futures and options contracts. Moreover, having selected these strategies, the benefits of hedging with futures contracts may be compared to options hedging under various interest rate scenarios.

The study begins with the mathematical derivation of return distributions to the unhedged fixed rate mortgage and the mortgage portfolios covered with various futures and options strategies. Using time series data collected on mortgage rates which are in turn converted to a mortgage price series, the mean capital gains and the standard deviation of returns for the unhedged portfolio are then estimated. Similar measures are computed for the covered portfolios utilizing the data on the T-bond futures contract prices and the put and call option premia, and are compared to the unhedged mortgage returns over the same period.

In the derivation of return distributions, and in estimating the mean-standard deviation pairs, two hedge ratios are considered: the one-to-one hedge ratio assumes hedging of a \$100,000 mortgage with one futures or option contract, while the risk minimizing hedge ratios suggest the hedge of an "optimal" amount of the mortgage with each contract. The optimal hedge ratios are estimated following an ordinary least square regression of the changes in mortgage price on the changes in the price of the futures contract during the period 1983-1991 (Ederington, 1979).

Since the time period considered in the study is one in which interest rates generally declined, and the mortgage and futures values increased, a simulation method is used to evaluate the risk-return of alternative strategies under rising interest rates. The simulation involves reversing the two price series: the mortgage and futures prices at the time of hedge initiation become the end of period prices, and prices at the termination of the hedge are used as the beginning price series. Options strike prices are adjusted accordingly, and if such put and call options were not traded in the market, option premia are estimated using the Black futures options pricing formula.

The two series are then combined to form a sample with no trend in the prices of either mortgages or the futures contracts, but with substantial variation in these prices. The return distribution to the combined series is also calculated and compared to those of the unhedged mortgage position. The study continues by discussing the results of the hedging strategies and concludes with a summary and suggestions for further studies.

FUTURES VERSUS FUTURES OPTIONS

This study employs options written on Treasury bond futures contracts rather than options on Treasury bonds in hedging mortgage portfolios. The merits of using futures, options on futures, and options on T-bonds are discussed here before proceeding with the empirical study.

Prepayment is a substantial problem for financial institutions attempting to hedge in the futures market: as interest rates fall, the value of the mortgage portfolio will rise, but borrowers will begin to prepay their mortgages and take out new ones at the lower rates. Therefore, the value of the mortgage portfolio may not appreciate for the institution, while the futures position is declining in value. The net result may be a loss in the futures market, without a corresponding gain in the portfolio of mortgages. So, institutions are able to protect themselves from rising interest rates but not from losses during periods of declining rates. This may make the futures market an unreliable vehicle for hedging mortgage portfolios.[2]

One advantage of using futures options as hedging instrument is that the option offers protection only on one side of the market compared to a futures market position that is affected by both sides of the market. If the financial institution chooses the "appropriate" option hedging strategy, it can protect itself only against the one-sided risk of rising interest rates.

Moreover, if the institution elects to engage in purchasing an option as the hedging method, it may benefit from the fact that margin requirement for options on futures are not subject to daily settlements. Hence the institution may not be adversely affected in cases of large movements of the futures contract price. In other words, the institution need not mark the account to market at the end of every day, thus eliminating the need to have large sums of cash at hand to avoid the risk of frequent margin calls. If the institution, on the other hand, decides to write an option as the hedging strategy, it remains subjected to daily settlements.

Critics of futures options point out that investors in such instruments are twice removed from the cash market, making hedging strategies more complex compared to options on cash instruments. However, when it is advantageous to exercise options on Treasury futures, investors move from one leveraged position to another. While exercising the option on bonds requires payment of the full market price of the security in cash, the exercise of a futures option requires only margin money to establish the futures position. Furthermore, protection continues through the futures position even after the option on futures is exercised.

Other advantages of options on futures over options on cash bonds include the availability of an array of deliverable bonds against a futures contact versus the specific bond issues deliverable against a T-bond option. Moreover, the underlying asset for futures options is extremely liquid, and premiums for such options reflect the competitive, continuous pricing of T-bond futures. Finally, futures contracts, and options on futures are traded on the same floor whereas cash securities and options written on them are not.

METHODOLOGY AND DESCRIPTION OF THE DATA

In this section, mathematical expressions of return distribution to the unhedged mortgage portfolio, as well as portfolios hedged with futures and futures options are discussed. The optimal hedge ratios are also derived following a simple regression of changes in mortgage prices on changes in the value of the futures contracts for the period 1983 to 1991 (Ederington 1979).

The specific hedging scenarios are as follows: On the 15th day of the month the financial institution aims in managing mortgage portfolio price risk resulting from potential changes in interest rate. On the same day, the institution may decide to enter an opposite position in the futures markets. Thus, a number of futures contracts will be sold on that day for each $100,000 of mortgage portfolio.

The exact number of the these contracts may be one if the hedger follows a one-to-one hedging strategy, or other than one if the hedger employs an optimal ratio derived from the regression method subsequently discussed. This study considers two hedge ratios as estimated in the next section: the uncorrected-for-autocorrelation ratio of the lagged series, .8991, and the corrected-for-autocorrelation ratio of the same series, .7993 (Hillard and Haney, 1982). The position will be maintained for six months at which time the institution will take an offsetting position in the futures market, thus realizing a gain or a loss depending on the direction and magnitude of changes in futures prices. This change, ideally, should wholly or partly offset the gain or loss in mortgage values.

Alternatively, the institution may elect to purchase one put option contract to cover either \$100,000 of mortgage value if a one-to-one hedge is used, or to cover a larger amount of mortgage portfolio when optimal hedging is employed. The optimal ratios of .8991 and .7993 translate to the covering of either \$111,222 or \$125,109 of mortgage amount with one put option respectively.

Finally, the financial institution may hedge the interest rate risk associated with its portfolio of fixed rate mortgages with the synthetic futures position: purchasing a put option and simultaneously selling a call option. Again, the size of the mortgage portfolio depends on the hedge ratio used.

The optimal hedge ratios and the mathematical expressions to compute the return to the unhedged mortgage positions, as well as those of the mortgage position hedged with a short position in financial futures, a long position in options on futures, and the synthetic futures are subsequently derived.

UNHEDGED MORTGAGE PORTFOLIO

If the cash instrument's prices at time t_1 and t_2, are M_1 and M_2 respectively, where $t_2 > t_1$, the value of gains or losses from the unhedged mortgage position is

$$U = X_M(M_2 - M_1) \tag{1}$$

where X_M = size of the cash position in multiples of \$100,000

The expected value and variance of the unhedged position may then be defined as

$$E(U) = X_M\, E(M_2 - M_1), \tag{2}$$

and

$$Var(U) = X^2_M\, Var(M) \tag{3}$$

where Var(M) is the subjective variance of the cash instrument and E is the expectations operator.

FUTURES HEDGING AND DERIVATION OF OPTIMAL HEDGE RATIOS

Based on the traditional hedging theory, emphasizing the pure risk-avoidance characteristics of futures markets, the hedger would take a position in the futures markets equal to, but opposite of, his/her position in the cash market (Figure II). This argument is based on the assumption that cash and futures instruments' prices generally move together, and thus, the gain or loss on the hedged position would be less than that for an unhedged position. Denoting the prices of the futures and cash instruments as F_t and M_t respectively, traditional hedging theory assumes that the changes in basis, F_t-M_t, are quite small relative to the price of the instruments because of the possibility of making or taking delivery of the commodities.

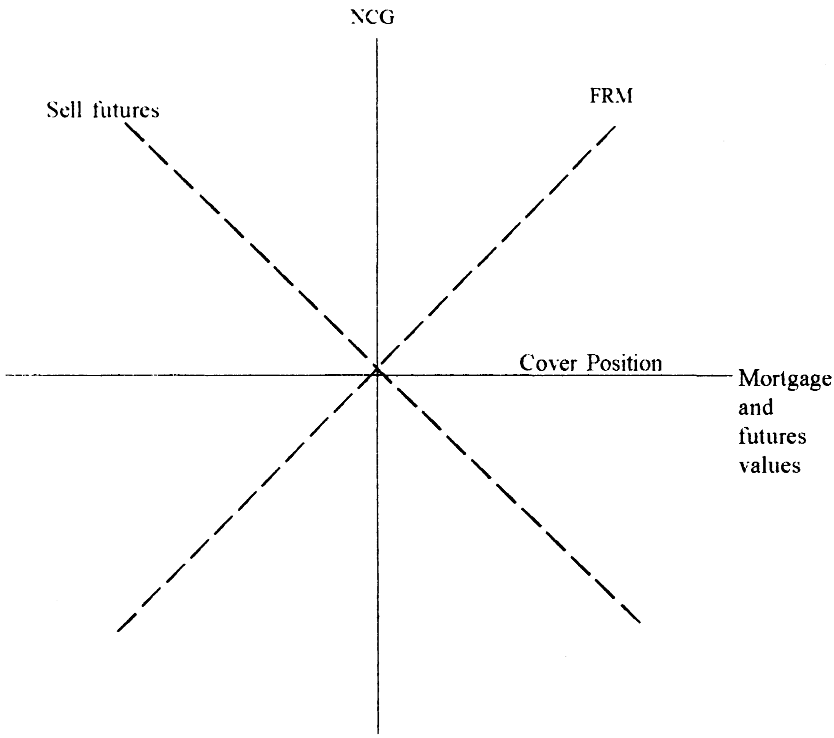

FIGURE II. Net capital gain from the FRM covered with the sell-futures strategy

If R represents the change in the market value of the portfolio which contains X_M and X_F holdings of the cash and futures market instruments respectively, and if n represent the number of futures contracts traded for each unit of the cash instrument held, i.e., $n = -X_F/X_M$, the expected return and variance of the hedged positions are

$$\begin{aligned} E(R) &= X_M E(M_2-M_1) - nX_M E(F_2-F_1) - C(X_M,n) \\ &= X_M [E(M_2-M_1) - nE(F_2-F_1)] - C(X_M,n) \end{aligned} \quad (4)$$

and

$$\begin{aligned} Var(R) &= X^2_M Var(M) + n^2X^2_M Var(F) - 2nX^2_M Cov(M,F) \\ &= X^2_M [Var(M) + n^2Var(F) - 2nCov(M,F)] \end{aligned} \quad (5)$$

where $C(X_F)$ represents brokerage and other costs of undertaking futures contracts including the cost of providing margins. and var(M), var(F), and cov(M,F) represent the subjective variance and covariance of the possible price changes between periods one and two. Although margin costs are not known with certainty, they have been stable over time. It is thus assumed than the variance of $C(X_F)$ is zero.

Working (1953) criticized the pure risk-minimizing assumptions of the traditional theory and argued that hedging was undertaken primarily to maximize profits. Holders of a long cash position would only sell futures contracts if they expected a narrower basis. Johnson (1960) and Stein (1961) developed a unified theory of hedging by applying basic portfolio theory to incorporate the traditional risk-minimizing criteria and the maximization aspects of expected profit theory. Ederington (1979) assumed hedging of one cash instrument and subsequently derived the optimal proportion of the cash instrument to be hedged in the futures markets when changes in basis are not necessarily equal to zero. The current study continues to derive the optimal hedge ratios following a regression method similar to Ederington's.

Letting the expected change in basis be E(ÄB) = $E[(F_2-M_2)-(F_1-M_1)]$, the expected return on the hedged position is

$$E(R) = X_M[(1-n)E(\text{ÄM}) - nE(\text{ÄB})] - C(X_M, n) \tag{6}$$

where $E(M_2-M_1)$ is the expected change in the price of one unit of the cash instrument.

Equation 6 shows that if the expected change in the basis is zero, as in the traditional theory, the expected gain/loss of the hedged position, E(R), is reduced as n approaches one. It may also be seen that changes in the basis can add to, or reduce, the return that would have been expected on the unhedged position where $E(U) = X_M(M_2-M_1)$.

Since the size of the holding of the cash instrument is assumed to be constant, the effect of a change in n on the variance of the return is

$$Var(R)/\ n = X^2_M[2nVar(F) - 2Cov\ (M,F)] \tag{7}$$

and the risk minimizing hedge ratio is

$$n^* = Cov(M,F)/Var(F) \tag{8}$$

The numerical value of Cov(M,F)/Var(F) may be estimated from historical data with an ordinary least square regression of (M_2-M_1) observations on (F_2-F_1) observations. The regression coefficient for (F_2-F_1) is the estimate of Cov(M,F)/Var(F).

It has been implicitly assumed that $n^* > 0$ in this discussion, so that the cash position is hedged with a short position in the futures instrument. Moreover, it has been assumed that the basis is stable over time, i.e., although the prices of the cash and futures instruments may not move together, the relationship between the two, once determined, remains constant. The data used in the estimations are monthly observations for the six-month changes in the mortgage and Treasury bond futures contract prices, since a six-month hedge period is considered in this study. It is further assumed that the first hedge was established on January 15, 1983, and the last hedge lifted on December 15, 1991. The result of the estimations are reported in Table 1.

TABLE 1. Regression estimates for changes in mortgage and futures prices and the derivation of optimal hedge ratio, b.

	CONTEMPORANEOUS HEDGE $ÄM_t = a + b.ÄF_t$		LAGGED HEDGE $ÄM_t = a + b.ÄF_{t-1}$	
	Uncorrected For Autocorrelation	Corrected For Autocorrelation	Uncorrected For Autocorrelation	Correctedd For Autocorrelation
a	.0831	.3571	-.5567	.1265
b	.7821	.6132	.8991	.7993
n	102	102	101	101
d.f	100	100	99	99
R^2	.2922	.4076	.3542	.4256
D-W	.4943	1.0731	.9821	1.2969

The slope coefficient for the regression of the changes in mortgage prices on changes in the futures contract prices using the six-month periods is .7821[3]. This means that in order to minimize the risk of the position, each $100,000 of mortgage holdings would be hedged by selling .7821 Treasury bond futures contracts. The coefficient of determination for this regression is .2922 signifying that a large portion of the movement in mortgage values is not accounted for by the changes in futures prices. The value of Durbin-Watson statistic, .4943, suggests a large degree of autocorrelation among the residuals. When the estimates are corrected for autocorrelation, the optimal hedge ratio drops to .6132 with r^2 of .4076.

In both of the above cases, a noticeable portion of mortgage value changes is found not to associate with changes in futures contract price. It was shown by Hillard and Haney (1982) that during the latter parts of the 1970s, changes in mortgage interest rates lagged behind changes in the yield on long-term government bonds by approximately one month. Since the yield on government bonds move parallel to the movement in futures prices, the relationship between changes in mortgage prices and changes in future prices are re-estimated incorporating a one month lag. In other words it is assumed that mortgages were hedged a period earlier by selling futures contracts--the mortgage portfolio of 2/15/83 was hedged in 1/14/83 as an example.

The results of the re-estimation shows the optimal hedge ratio as .8991 with r^2 equal to .3542 for the uncorrected, and .7993 with coefficient of determination at .4256 for the corrected series.

OPTIONS HEDGING

While hedging with financial futures may be beneficial and desirable in many instances, a closer examination of the mortgage lending institution's hedging objectives reveals that other, "more suitable" hedging instruments are available. The undesirable changes in mortgage values for the banker are only those stemming from an increase in market rates; higher prices as a result of declining interest rates may indeed be welcomed. The risk of owning a portfolio of FRMs is then the probability of rising market rates only. If mortgage bankers were able to "insure" against adverse and undesirable changes in the value of their FRM, they should be willing to hold them as well. This one-sided protection or "insurance policy" may be in the form of hedging strategies with options on financial futures.

An option is defined as the right, but not the obligation to buy (call option) or to sell (put option) an asset for a predetermined price (E) at a predetermined date (European type option) or during a predetermined period (American type option). For this privilege, the buyer pays and the seller receives the option premium.

The buyer of a put option on Treasury bond futures contracts with a strike price of E, for example, would only exercise the option if interest rates rise causing market prices to fall below E. A fall in interest rates and the resulting price increase leaves the option unexercised and the paid premium lost. The seller of a call option with strike price E, incurs a loss equal to the difference between the market and exercise prices modified by the premium received only when interest rates decline prompting the holder of the option to exercise his\her right to buy at E instead of the now higher market price.

Hedging the fixed rate mortgage through purchasing put options on Treasury bond futures (Figure III), sets a limit on the loss in mortgage value resulting from higher interest rates without limiting the potential for gains if interest rate were to fall. Specifically, the put option purchased with an exercise price equal to the futures contract price at time of initiating the hedge, t, at a premium of P_t, would only be exercised if the futures price were lower at the time the hedge was lifted. This would create a gain of F_T-E. The option would expire unexercised otherwise. The expected return to the hedged position is then

$$E(R_P) = (M_2\text{-}M_1) + (E\text{-}F_T) - P_t$$
$$= (M_2\text{-}M_1) - P_t \qquad (9)$$

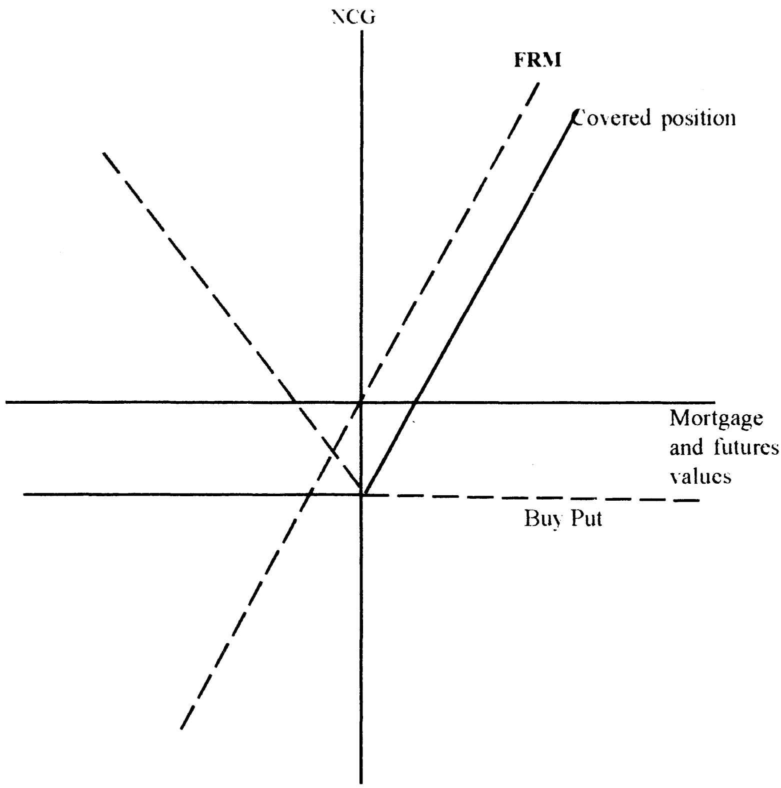

FIGURE III. Net capital gain from the FRM coovered with the buy-put strategy

To correct for the existence of a non-zero basis, the previously derived hedge ratios may be also used in options hedging. So, instead of hedging one mortgage contract through buying one put option, it is assumed that $1/n^*$ units of the cash instrument is hedged with the purchase of one put. Intuitively, it is easier to do this rather than assuming that partial option contracts are purchased to cover one unit of the cash instrument. Hedging the mortgage with put options according to the optimal hedge ratio, would yield

$$E(R^*_P) = 1/n^* (M_2\text{-}M_1) + (E\text{-}F_T) - P_t = P_t{}^4 \qquad F_T<E$$
$$= 1/n^* (M2\text{-}M1) - P_t \qquad F_T>E \quad (10)$$

Combining a short position in financial futures call options with a long position in the put options on the same contract provides a total return similar to the hedge with selling futures contracts (Figure IV). The long-put hedges against a rise in rates and the short-call trades away some of the seller's upside potential in a rally in return for premium income that will offset some or all of the cost of the put. The expected return for the hedged position is

$$\begin{aligned} E(R_{CP}) &= (M_2-M_1) + (E-F_T) - P_t + C_t \qquad F_T<E \\ &= (M_2-M_1) - (F_T-E) - P_t + C_t \qquad F_T>E \end{aligned} \tag{11}$$

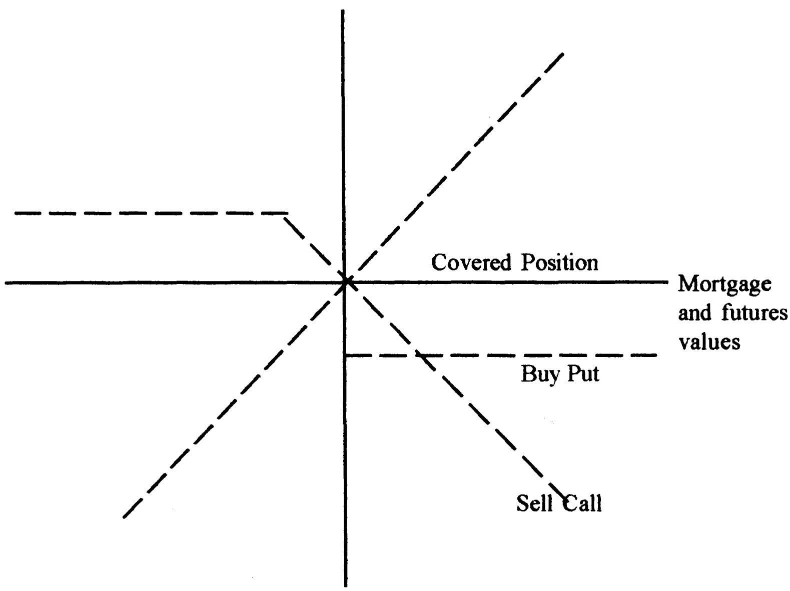

FIGURE IV. Net capital gain from the FRM covered with the combined byu-put/sell call (synthetic futures) strategy

Hedging $1/n^*$ units of the mortgage using this strategy changes the expected return as follows,

$$\begin{aligned} E(R^*_{CP}) &= 1/n^*(M_2-M_1) + (E-F_T) - P_t + C_t \quad F_T<E \\ &= 1/n^*(M_2-M_1) - (F_T-E) - P_t + C_t \quad F_T>E \end{aligned}$$

or $$E(R^*_{CP}) = -P_t + C_t \qquad F_T<>E \tag{12}$$

Assuming the equality of put and call premia for all at-the-money options,

$$E(R_{CP}) = 0 \tag{13}$$

DATA SPECIFICATION

The length of each hedge period is six months and a new hedge was initiated on the 15th day of every month beginning January 1983 and ending in December 1991. Therefore, a total of 102 hedged positions are considered. The year 1983 is chosen as the starting date since options on futures contracts were first introduced three months prior to that time and by the beginning of that year there was considerable volume of trade in the market.

Mortgage rates used in the study are those on fixed rate conventional, fully amortized first mortgages on single family homes closed in the third week of every month for all lender types. This mortgage rate series was obtained from the Federal Home Loan Bank Board of Des Moines for the period 1983-1988 and then from the Office of Thrift Supervision for the remainder of the period under study.

The mortgage rate series is converted into a price series with the use of "The prepayment mortgage value table for the 30-year mortgage prepaid in twelve years" extracted from Thorndike Encyclopedia of Banking and Financial Tables, Revised Edition. Prepayment in twelve years is assumed because it roughly corresponds to the expected life of recently originated conventional mortgages.

The Treasury bond futures contract chosen is the one with maturity lasting at least to the last day of the hedge period. The futures price used is the settlement price for the 15th day of the month and in those cases where the 15th day was not a trading day, the price for the closest alternative day is used. The premium for put and call options on T-bond futures contracts with strike prices closest to the futures price and maturities of equal or greater than those of the underlying futures contract are also obtained for a trading day as close to the middle of the month as possible. Similar data are gathered for the next in-the-money and out-of-the-money puts and calls.

The futures price series and put and call option premia are collected from the statistical annual published by the Chicago Board of Trade for the period October 1982 to December 1986, and from the Wall Street Journal for the years 1987 through 1991.

It is then assumed that the financial institution aims to hedge a portfolio of thirty-year mortgages with an interest rate of eight percent and expected prepayment in twelve years. This mortgage type is used since it is essentially on the same footing as the T-bond futures contracts which are based on an eight-percent-coupon Treasury bond.

The period under this study is one in which interest rate levels generally declined, and the mortgage and futures values consequently increased. There was considerable variation within the changes in mortgage values. Of the 102 six-month hedge periods considered, sixty-one were periods in which mortgage values increased and the remaining forty periods showed a decline in values.

The maximum increase in value, 9.05 points[5], occurred between November 1985 and May 1986 and the minimum gain was .060 points, for the period August 1987 to February 1988. The maximum loss in value of 6.300 points happened in 1987, April to October, and the minimum loss was .050 points, between March and September 1983

One of the main advantages of using options on futures is that the holder has the right, but not the obligation to take a position in futures markets. So, the return to mortgages hedged with a long position in futures put options, for example, rather than futures contracts should be relatively more favourable when mortgage values and futures prices generally rise. Of course, the mortgage value must increase by at least an amount large enough to offset the premium paid for the put option before the benefits of this hedging strategy materialize. Referring back to Figure III, mortgage value must increase above k" before any gains are realized.

In order to evaluate the risk-return of alternative strategies under rising interest rates, a simulation method is used in the current to reverse the mortgage and futures price series. Consequently, the mortgage and futures prices at the time the hedge was initiated become the end of period prices, and prices at the time of hedge terminations are used as the initiating price series. The strike prices of the options are then adjusted to represent the new initial futures prices, and the new option premia are obtained from the sources mentioned previously. In cases when options with the new strike prices were not traded, the option premia is estimated according to the Black futures options pricing formula using the one month historical variance and the six-month Treasury-bill rate.[6]

When the two series are combined, the resulting sample would represent a series in which there is no trend in the prices of either mortgages or the futures contracts, but there remains substantial variation in these prices within the period.

DISCUSSION OF THE RESULTS

The results of the hedging exercise are categorized base on the specific interest rate scenarios used. The "original series," represents an increasing interest rates environment and thus falling mortgage and futures prices, while the "reverse series" illustrates rising rates and falling prices. As discussed earlier, The use of options on futures contracts rather than futures contracts should be beneficial when rates rise. The results of the study are discussed here to verify this theoretical expectations. To begin with, however, the results are discussed for the "combined series" where no trend in the direction of the movements in interest rates exist.

RETURN DISTRIBUTION FOR THE COMBINED SERIES

The result of the hedging exercise for the combined series is reported in Table 2. Return distributions are estimated for the one-to-one hedge of the mortgages with T-bond futures and options on the futures, as well as for the optimal hedges of the mortgage portfolio with each strategy. The first entry in each column shows the mean returns from a position in a $100,000 unhedged fixed rate mortgage portfolio, and the mean return from the same portfolio if hedged with various hedging strategies and according to different hedge ratios. Brokers fees are not considered in this study, so the returns may be slightly overestimated. The second number in each column refers to the standard deviation of returns for the hedged and unhedged mortgage positions.

The return for the unhedged mortgage and mortgages hedged with futures are zero. This is expected as reversing the mortgage and the futures price series would simply reverse the sign of return without changing the magnitude. The standard deviations of return for the hedged position are lower for all hedge ratios. The one-to-one hedge of the mortgage series with financial futures reduces the standard deviation of return by 24 percent, from 4.823 to 3.651 points. Using the uncorrected optimal ratio of .8991 lowers the standard deviation to 3.307 points and the use of optimal hedge ratio corrected for autocorrelation, .7993, accounts for standard deviation of 3.005 points. These numbers translate to a reduction of 31 and 38 percent respectively.

The buy-put strategy is quite successful in lowering the variability of return when compared with the unhedged mortgage position. For at-the-money puts, the standard deviations of return are lower in all cases with the best result of 56 percent lower standard deviation in the case of corrected optimal hedge of the mortgage series. However in all cases, the return to the hedged positions are negative, with the one-to-one hedge showing a smaller decline in returns as compared to the optimal hedges.

The use of the in-the-money put option, $E>F_t$, as the hedging instrument produces curious results. The standard deviation of returns are generally higher as compared to the hedge with the at-the-money put, but return are surprisingly lower as well. On the other hand, the out-of-the-money put creates a better return, i.e., a smaller loss, at the expense of higher variability. These results may be attributed to a possible overpricing of put options and will be discussed later in this section when comparing the result of the study for the original and the reverse series.

The synthetic futures hedge, selling calls and buying puts with the same strike prices and assuming equal put and call premia, is expected to create a return similar to that of the mortgage position hedged with futures contracts. Indeed, for all cases of optimal hedges with the at-the-money options this seems true. The returns to this position are .080 and .081 points for the uncorrected and corrected optimal hedges respectively, and -.589 for the one-to-one hedge. On average, then, there is a loss of approximately $43 to this

position. The standard deviation of returns are lower than that of the unhedged mortgage by 17 to 30 percent.

TABLE 2. Return distribution for the hedged and unhedged mortgage positions, combined interest rate series, one-to-one and optimal hedge ratios of the lagged hedge. ($000)

	ONE-TO-ONE HEDGE RATIO		OPTIMAL HEDGE RATIO			
			UNCORRECTED FOR AUTOCORRELATION		CORRECTED FOR AUTOCORRALATION	
	Mean Capital Gain	Standard Deviation Of Return	Mean Capital Gain	Standard Deviation Of Return	Mean Capital Gain	Standard Deviatioon Of Return
UNHEGED MORTGAGES	0	4.823	0	4.823	0	4.823
MORTGAGES + FUTURES	0	3.651	0	3.307	0	3.005
MORTGAGES + PUT OPTIONS						
E<F	-0.989	3.118	-1.191	3.016	-1.024	3.289
E=F	**0.623**	**3.033**	**-1.922**	**2.862**	**-1.769**	**2.112**
E>F	-0.925	3.042	-2.981	3.032	-2.824	3.267
MORTGAGES + LONG PUT + SHORT CALL						
E<F	-0.781	3.379	1.260	4.691	1.346	5.217
E=F	**-0.589**	**3.359**	**0.080**	**3.555**	**0.081**	**3.997**
E>F	-0.477	3.412	-2.344	4.755	-2.323	5.167

When compared to the short-futures hedging, however, the synthetic futures does not perform as well. The one-to-one hedge with the put-call strategy fares better than futures hedging in lowering variability of return although it creates a considerable loss. Optimal hedging with this strategy, on

the other hand, lowers the variability of the unhedged mortgage portfolio by a smaller amount as compared to hedging with futures.

The move to a higher exercise price results in a substantial loss for all optimal hedges using this strategy and increases the standard deviation by a large amount as well. The use of options with smaller exercise prices creates a considerable profit although it comes at the expense of quite larger variabilities. This may be due to relative overpricing of the put and/or relative underpricing of the call and will be mentioned later in the comparisons of the original and reverse price series.

RETURN DISTRIBUTION FOR THE ORIGINAL AND THE REVERSE SERIES

This section will focus on a more detailed analysis of each hedging strategy. The mean capital gains and the standard deviation of returns to the original and the reverse series are looked upon separately in an attempt to distinguish and explain the return distributions as they respond to the direction of the price movements. The magnitude of the change in mean expected capital gains as compared to the magnitude of the corresponding change in the standard deviation of returns are also discussed to better understand the effectiveness of each hedging strategy. Table 3 reports the results of the experiment for the original series while Table 4 presents the results for the reverse series.

For the original series, falling rates and rising values, futures hedging lowers potential gains for the benefit of lower variation of returns. Net capital gains are much closer to zero when mortgages are hedged with futures contracts. They range from a low of -.246 points (a loss of $246 on a $100,000 position) for the one-to-one hedge to a high of .036 points for the corrected optimal hedge. Standard deviation of return is lower by 24 to 38 percent as well.

Optimal hedging with futures performs better than the one-to-one hedge, returns are closer to zero and standard deviations are lower. This may be expected, as the discussion of the basis in section IV suggested that the use of an optimal number of futures contracts when the basis is not zero would increase the effectiveness of the hedge. Furthermore, When optimal hedge ratios are corrected for autocorrelation, both the return and the standard deviation improve considerably.

The optimal hedge of the mortgage series, although lowering the variability of returns by a large amount, is paid for through a corresponding large reduction in mean returns: A reduction of 31 percent in standard deviation at the expense of 109 percent lower return for the uncorrected ratio, and 38 percent lower variability costing 97 percent lower mean capital gains for the corrected optimal hedge ratio. The one-to-one hedge, lowers the variability by 24 percent and the return by 121 percent.

TABLE 3. **Return distribution for the hedged and unhedged mortgage positions, original series (rising interest rates), one-to-one and optimal hedges of the lagged series. ($000)**

	ONE-TO-ONE HEDGE RATIO		OPTIMAL HEDGE RATIO			
			UNCORRECTED FOR AUTOCORRELATION		CORRECTED FOR AUTOCORRALATION	
	Mean Capital Gain	Standard Deviation Of Return	Mean Capital Gain	Standard Deviation Of Return	Mean Capital Gain	Standard Deviatioon Of Return
UNHEGED MORTGAGES	1.162	4.823	1.162	4.823	1.162	4.823
MORTGAGES + FUTURES	-0.246	3.651	-0.104	3.307	0.036	3.005
MORTGAGES + PUT OPTIONS						
E<F	-0.855	2.768	-0.043	2.985	0.181	3.350
E=F	**-1.064**	**2.734**	**-0.892**	**2.889**	**-0.675**	**2.235**
E>F	-1.992	2.865	-1.980	2.894	-1.772	3.217
MORTGAGES + LONG PUT + SHORT CALL						
E<F	0.046	3.697	3.19	3.323	3.516	4.002
E=F	**-0.079**	**3.661**	**1.452**	**3.534**	**1.614**	**3.972**
E>F	-0.177	3.643	-0.422	3.497	-0.261	3.934

TABLE 4. Return distribution for the hedged and unhedged mortgage positions, re verse series (falling interest rates), one-to-one and optimal hedges of the lagged series. ($000)

	ONE-TO-ONE HEDGE RATIO		OPTIMAL HEDGE RATIO			
			UNCORRECTED FOR AUTOCORRELATION		CORRECTED FOR AUTOCORRALATION	
	Mean Capital Gain	Standard Deviation Of Return	Mean Capital Gain	Standard Deviation Of Return	Mean Capital Gain	Standard Deviatioon Of Return
UNHEGED MORTGAGES	-1.162	4.823	-1.162	4.823	-1.162	4.823
MORTGAGES + FUTURES	0.246	3.651	0.104	3.307	-0.036	3.005
MORTGAGES + PUT OPTIONS						
E<F	-1.742	3.370	**-1.182**	**3.332**	-2.032	3.315
E=F	-2.338	3.047	**-2.951**	**2.835**	-3.981	3.170
E>F	-2.229	3.288	**-2.862**	**2.989**	-3.875	3.317
MORTGAGES + LONG PUT + SHOR CALL						
E<F	-0.227	3.060	-0.671	6.058	-0.824	6.432
E=F	**-0.246**	**3.056**	**-1.292**	**3.576**	**-1.453**	**4.022**
E>F	-0.612	3.181	-4.266	6.013	-4.384	6.400

The reverse series provides collaborating results. The magnitude of returns for futures market hedging are always the same as the original series and have the opposite sign. Standard deviations are exactly the same. In general, then, standard deviation of returns are lowered if the futures hedge of the reverse series is undertaken, and the mean expected returns are more favourable and closer to zero as compared to the large loss of the mortgage value

So it is concluded that given the circumstances under this study, futures hedging is successful in lowering the variability of returns. Optimal hedge ratios are superior to the one-to-one ratio, and correction for autocorrelation improves the results.

Hedging mortgage risk by buying put options should limit the losses to the put premium if prices and values decline. Rising portfolio value due to lower interest rates, however, will also be modified. The banker who hedges with the buy-put strategy thus substitutes lower gains in return for limiting losses.

Over the period under the current study, the investor who chose this method of hedging did not do well in term of returns. For the original series, hedging with either the one-to-one or the optimal hedge ratios, lowers the gain in mortgage portfolio value substantially. The one-to-one hedge with at-the-money put creates a loss of -1.064 points compared to a potential gain of 1.162 points, a decline in mean capital gains of $2,226 or 191 percent. The optimal hedge ratios result in losses of -.892 and -.675 points for the uncorrected and corrected for autocorrelation respectively. In percentage terms the above losses are smaller, 177 and 158 percent respectively, as compared to the one-to-one hedge.

The purchase of the in-the-money put magnifies the negative effects which may be explained by guessing that the higher premia paid for this option more that offset the benefit of exercising it. In other words, since in this period interest rates declined and prices increased, the exercise of the option would be rarely warranted. Thus, a person who paid an average premium of 2.627 points ($2,627) for the at-the-money put or 3.636 points ($3,636) for the in-the-money option eliminated potential gains in mortgage value at a high cost. Conversely, the out-of-the-money put with average premium of $1,829 results in smaller declines in portfolio value as compared to the unhedged position.

The strategy, however, is quite successful in lowering the variability of returns. The one-to-one hedge lowers the standard deviation of return from an unhedged value of 4.823 points to 2.734--a reduction of 43 percent. The comparable futures hedging accounts for a smaller reduction in variability: the mortgage portfolio hedged with futures on an one-to-one basis has a standard deviation of return which is 25 percent higher than the variability of the mortgage covered with the buy-put strategy. This is true for the put with exercise price other than $E=F_t$ as well.

Optimal hedges with the put option are also very helpful in lowering the standard deviation of returns--54 percent lower for the corrected hedge ratio and 40 percent lower for the uncorrected-for-autocorrelation ratio. On average, variability is lower by 46 percent when mortgage portfolio is hedged with the buy-put strategy.

Falling prices represented by the reverse series result in a loss of -1.162 points in the value of the unhedged position. The price does not, however, fall by enough to compensate for the premium paid for the put option. Had prices fallen by a large amount, according to Figure 5, the loss would not have exceeded the paid premium. In this case, the average loss for the optimal hedge ratios is indeed on par with the average premium paid for the put option. The average premium paid to buy the put option is 3.440 points ($3,440) and the average loss is 2.907 points ($2,907). So, in fact optimal hedges do limit the loss at a level very close to average put premium, while the one-to-one hedge shows a smaller loss. This is expected as a one-to-one hedge covers a $100,000 mortgage with one option contract while the optimal hedge represents the hedge of a larger value with the same contract, ($n^* < 1$). The optimal hedge should then account for a larger loss[7].

The move to in-the-money puts with an average premium of 4.522 points magnifies the losses as well as increasing the variability of returns. Lower priced out-of-the-money puts, with average premium of 2.478 points, create smaller losses but higher standard deviations. This, in general, is not to be expected since in a period of falling prices the put is exercised. It must then be theorized that either due to a lower than expected rise in interest rates or as a result of overpricing of puts for the period under study, this hedging method is not successful for the reverse series. In other words, mortgage prices did not fall by enough to create large enough gains from the exercise of the costly put to compensate the buyer of the option for the paid premium.

The hedging of the original mortgages series with the sell-call/buy-put strategy using at-the-money options lowers variability for all hedge ratios. In this period of rising prices, the exercise of the call creates losses that are more than offset by the gains in mortgage value modified by the call premia received and the put premia paid. The optimal hedges increase returns by a low of .290 (25 percent) and a high of .452 (40 percent) as compared to the unhedged mortgage, accompanied with a change in variability of 27 to 18 percent lower.

The reverse series generates large losses for optimal hedges compared to the unhedged position, although the variability of returns are lower as well in all cases of hedging with the at-the-money options. The losses increase between 11 and 25 percent and standard deviations are lower by 17 to 26 percent respectively for the uncorrected and corrected hedge ratios. The one-to-one hedge lowers the mean capital loss as well as lowering the variability.

When compared to the futures hedge, the synthetic futures position creates more erratic results. Capital gains and standard deviations are much higher than the futures position for the original series, while both losses and standard deviations increase as compared to futures hedging for the reverse mortgage series.

The use of options with an exercise price different than the initial futures price creates larger fluctuations in returns and increases the standard deviation greatly. When E is smaller than F_t, the profits for the original series soar and the losses for the reverse series diminish. This may be due to the fact that the premium received for the new in-the-money call far exceeds the premium paid for the out-of-the-money put, on average 3.893 versus 1.829. Rising prices trigger the exercise of the call but do not create big enough losses to offset the large net premium received as well as the gain in mortgage value.

SUMMARY AND CONCLUSIONS

Hedging fixed rate mortgage portfolios with financial futures and options is suggested to substitutes for the adjustable rate mortgage as the hedging instrument. This study examines the benefits of three hedging strategies with futures and options on futures in lowering the standard deviation of returns of the unhedged fixed rate mortgage over the period 1983 to 1991.

Based on the results of the study, it is concluded that during this period the three strategies considered here are all beneficial in lowering the variability of return to a portfolio of fixed rate mortgages. This is true, in absolute terms, regardless of the direction of interest rate movements, although the comparative benefits of each strategy does depend on this trend. The financial institutions's choice of the hedging instrument should be decided based on it's specific hedging objectives and the expected changes in interest rates.

In the case of the risk avoidance or insurance hedge, the aim is to protect the cash position from adverse price fluctuations. The sell-futures strategy seems suitable for this purpose. On the other hand, the primary goal of a selective or discretionary hedge is to prevent large losses in the value of the cash instruments by attempting to forecast the direction of the price. The buy-put strategy is ideal in this situation since the portfolio would be insured against falling values without limiting the potential gains if interest rates decline and prices rise.

For the simulated case of combined mortgage and futures price series--where there is substantial variation in prices without an upward or downward trend--hedging with at-the-money put options performs the best in lowering the variability of returns, although this is achieved at a larger cost as compared to the other two strategies. The use of near-the-money put options provides consistent results: out-of-the-money put creates smaller losses and a smaller reduction in standard deviation; in-the-money put creates larger losses and lowers the variability by a smaller amount. The risk minimizing optimal hedge ratios are more successful in lowering the variability, but create larger losses as compared to the one-to-one hedge ratio, and when corrected for autocorrelation, the optimal hedge ratio hedging is more successful in lowering the standard deviation.

Hedging with financial futures creates a net profit of zero while reducing the standard deviation of returns by a respectable amount. Similarly, the synthetic futures hedge with at-the-money options performs well in lowering the standard deviation, although not on par with the futures and the buy-put hedges. The loss from the position, however, is much smaller than losses created by the put option hedge and roughly equals those of the futures case.

The original series--falling rates and rising values--presents a case when options hedging may be preferable to hedging with futures. The futures hedge is successful in lowering the standard deviation, but also lowers the returns considerably. The hedge with put options is much more successful than the futures hedge in lowering the variability, but creates slightly larger losses. The hedge with the buy-put/sell-call strategy, lowers the variability, with a potential gain in value.

For the simulated reverse series when rates rise and prices fall, futures hedge performs as expected: lowering the variability and limiting the loss to a level near zero. If the primary purpose of the hedge is to lower variability of returns, the buy-put hedge may again be recommended. The optimal hedge with the put option is quite successful in lowering the variability (better than the futures), but does create large losses (roughly equal to the put premium). Out-of-the-money puts with smaller premia create a more manageable loss, and lower the variability on par with financial futures. Finally, the combined strategy of buy-put/sell-call creates a loss larger than the futures hedge, but lower than the put option hedge. The variability is lowered by a respectable amount.

The above results show that covering the FRM through futures and options markets strategies are successful in lowering the variability of returns. The relative advantage of each strategy in terms of the mean-standard deviation pairs, however, depends on the direction of interest rate movements. Since the primary purpose of financial institutions in hedging interest rate risk associated with their portfolio of fixed rate mortgages is to prevent values from falling, the use of put-options on financial futures as the hedging instrument is recommended. Moreover, the use of this strategy in place of adjustable rate mortgages may have implications on the pricing of the two mortgage types relative to each other. If the same purpose is served by either of the two strategies, the cost of the option as the "insurance instrument" should be the difference between the ARM rate and the FRM rate.

FOOTNOTES

[1] There is an inverse relationship between interest rates and security prices. For example, assuming that a bond with 30 years remaining to maturity was issued at par (100), with a coupon of 8% to reflect market rates at the time of the issue, if market rates rise to 10%, it would be traded below par at 87.07 to have a yield comparable to market rates.

[2] Marshal and Colwell, "Hedging Mortgage Portfolios with Options on futures", *Real Estate Developments*, 1986: 7

[3] The Coefficient was significant at the .0001 level.

[4] $(E - F_T) = (F_t - F_T)$, assuming the purchase of an at- the -money put at the start of the hedge period. If n^* is the optimal hedge ratio, then $(F_T - F_t)$ and $1/n^* (M_2 - M_1)$ cancel each other. The expected return on the mortgage position hedged with the buy put strategy when $F_T < E$ is simply P_t.

[5] All mean returns and standard deviation of returns are expressed as thousands of dollars. 9.050 points, then, equals $9,050.

[6] Black, Fisher. (1976): "The Pricing of Commodity Contracts. " *Journal of Financial* Economics 3: 167-179.

[7] The corrected hedge ratio of .7993, for example, means that (1 / .7993)* $100,000 of mortgages portfolio is being hedged with the purchase of one put option contract.

Consequently, the average loss of \$1,162 per \$100.000 of mortgages would on average equal to 1 / .7993 times as high for this optimal hedge. The loss, in other words is 1.251 * \$1,162, or \$1,453 for the optimal hedge. So, the average loss for the one -to-one hedge is smaller than the average loss for the optimal hedges.

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Ramin Cooper Maysami
School of Accountancy and Business
Nanyang Technological University
Nanyang Ave, Singapore, 2263

A Comparison of Self-and Superior-Appraisals of Divisional Level Managers' Performance in Selected Australian companies

Teoh Hai Yap

ABSTRACT

This study reported the results of a comparison between self- and superior-appraisals of divisional level managers' performance in selected Australian manufacturing companies, in terms of four psychometric properties: leniency errors, halo effects, convergent validity and discriminant validity. Significant differences existed between the managers' and their superiors' appraisals based on these criteria. The findings from this study provided further evidence on the performance appraisals issue and suggested that the exclusive use of the self-appraisal method in performance evaluation research should be viewed with caution. Further research using different settings and at different organisational levels would be warranted.

ABSTRACT

Kajian ini melaporkan keputusan perbandingan diantara penilaian diri dengan penilaian ketua ke atas prestasi pengurus-pengurus separa bahagian di dalam syarikat-syarikat pembuatan Australia, dari segi empat Psikometrik, ia itu ralat kesan halo, kesahan konvergen dan kesahan diskriminan Terdapat perbezaan bermakna di antara penilaian pengurus-pengurus dengan penilaian ketua-ketua mereka berdasarkan kriteria-kriteria berkenaan. Penemuan kajian ini menambahkan lagi bukti ke atas isu-isu penilaian prestasi dan mencadangkan yang penggunaan exclusive kaedah penilaian diri dalam penyelidikan penilaian prestasi perlu digunakan dengan berhati-hati. Kajian lanjut dianjurkan dengan menggunakan situasi dan para organisasi yang berlainan.

INTRODUCTION

In performance evaluation research managers are commonly asked to subjectively rate their individual performances on scales corresponding to a set of predetermined performance criteria. Underpinning the self-rating method is the theory of self-perception. This theory argues that individuals can often be active observers of their own behaviors (Bem, 1967; 1972). Also, each individual possesses an extensive data base concerning that individual than anyone else (Jones and Nisbett, 1971). Researchers tend to use the self-rating method over other methods, such as superior- and peer-ratings, to obtain performance information because it is difficult to collect properly matched objective data in a cross-organizational study compared to self-rating data (Govindarajan, 1984), and also because Heneman's findings (1974) have often been cited as an authoritative source supporting the self-rating method (see, for example, Govindarajan, 1984; Brownell and McInnes, 1986). Heneman (1974) found a high correlation between self- and superior-ratings, and suggested that "self-ratings of managerial performance hold promise as a means for expanding the scope of research on managerial performance" (p 638).

However, accuracy of self-rating may be impaired in several ways. According to Campbell and Lee [1988] the discrepancy between self- and superior-ratings could be attributed to the superior differences in the nature and extent of three constraints encountered by the self-rater and superior. For example, the superior might have less knowledge about job requirements, hence was faced with higher information constraints. The superior might focus on performance attributes which are person-oriented, whereas the self-rater might focus on situation-oriented attributes, leading to differences in their cognitive constraints. Finally, the superior might also be subjected to affective constraints such as feelings of threat, friendship and interdependence when making an evaluation, whereas the self-rater might be more affected by self-esteem (DeNisi et al. 1977; Jones 1973), self-enhancement (Mabe and West, 1982) and a tendency to present himself to others in socially desirable ways (Shrauger and Osberg, 1981).

The results from past studies offered inconsistent evidence about the convergence between self- and superior-ratings. This has led some researchers to express reservations about the usefulness of self-ratings, except as a vehicle for personal development (Campbell and Lee, 1988). So as to provide further insights on the issue, this paper reported the findings of an empirical study which tested for leniency errors, halo effects, convergent validity and discriminant validity between self- and superior-ratings of divisional level managers' performance in selected Australian manufacturing companies.

LENIENCY ERRORS

Leniency errors occur when self- and superior-ratings are significantly different. Thornton (1968) investigated the relationship between the self- and superior-perceptions of first-level supervisors. He found leniency of self-ratings relative to superior-ratings. Greater leniency effects of self-ratings were also reported in performance studies of technical employees (Klimoski and London, 1974) and managerial and professional employees (Holzbach, 1978). In contrast, Heneman (1974) found mean self-ratings were significantly lower than the corresponding superior-ratings for three of nine performance dimensions, indicating greater leniency errors for superior-ratings. If leniency errors in fact exist, this may suggest that either self-raters could have included dimensions of performance ommitted by superior-ratings or there are perceptual differences on the relative importance of various aspects of the subordinates' job.

HALO EFFECTS

Halo is the tendency by a rater to allow strong positive or negative impressions formed early in a series of observations to influence ratings on all subsequent observations. Thus, instead of evaluating according to the distinct dimensions of performance, the rater evaluates based on a global or overall judgment, giving rise to rater bias (Holzbach, 1978). Halo error is measured by the magnitude of intercorrelations among performance dimensions for each rating source (self and superior). Heneman (1974) found the intercorrelation for self-ratings was significantly less than the corresponding intercorrelation for superior ratings, suggesting greater halo effects for superior ratings. In other words, when evaluating the managers, superiors took a "global" view, unlike when the managers rated themselves.

CONVERGENT VALIDITY AND DISCRIMINANT VALIDITY

Convergent validity is measured by the extent of agreement between self- and superior-ratings on the same performance traits or dimensions. A lack of significant agreement indicates that the different rating methods are measuring different performance traits and this implies a lack of validity in at least one of the methods (that is, self- or superior-ratings).

Discriminant validity refers to the distinctiveness of each of the performance traits, so a lack of significant agreement between different rating methods on different traits indicates that there is discriminant validity.

Convergent and discriminant validity can be assessed using the multitrait-multimethod (MTMM) matrix suggested by Campbell and Fiske (1959). This matrix technique involves analysis of performance ratings data obtained from self- and superior-ratings on a number of performance items in the questionnaire instrument. The self- and superior-rating sources constitute the multimethods and the performance items in the rating instrument the multitraits. The procedure has been employed to overcome the limitation of using a single-rater single-trait approach by giving recognition to the fact that, while a test can be constructed to measure an underlying construct of interest, scores on that test may also be affected by the testing method used. By analysing more than one trait and more than one method simultaneously, this enables the examination of variance that can be ascribed to traits (trait variance) and the variance that is ascribed to methods (method variance). The MTMM thus provides a better understanding about the meaning of the performance ratings than could be obtained by a single-rater single-trait approach.

METHOD

SUBJECTS

A sample of companies was selected from a business directory to whom initial letters were sent to seek their participation in this research. The selection was based on two criteria: all companies selected were from the manufacturing industry and employed three hundred or more people. Since the unit of analysis was the first-level managers immediately below the corporate office senior executives, it is important that a company should have several divisions. Also, the participating companies would be visited for data collection so the sample was confined to the Metropolitan Sydney and Wollongong areas.

Interviews were arranged with managing directors (or general managers) of the participating companies during which the objective of this research was explained, at the same time the researcher was able to gain a basic understanding of each participating company's business background, organization structure and performance evaluation system characteristics. In this way the level of division managers for the purpose of self-rating was identified, as well as the names of each divisional managers and their immediate superiors.

QUESTIONNAIRE AND ADMINISTRATION

The MTMM procedure requires a researcher to collect measures of at least three different traits or dimensions of performance, using at least two different rating methods. Managerial performance for this study was measured on eight performance dimensions using an instrument developed by Mahoney et al (1963), Mahoney (1964) and adopted by Heneman (1974). Moreover, this instrument has frequently been used in performance evaluation research (Brownell, 1982; Brownell and McInnes, 1986). Respondents were asked to rate performance on a 7-point Likert-scale format on each of the eight management functions. An overall effectiveness question was also included. One reason for this overall rating was to overcome the halo effect that often arises from overall performance when other ratings are given. Using the two rating methods (self- and superior-ratings) to measure each of the eight performance dimensions, this produced an 8 (trait) x 2 (method) MTMM matrix.

Two sets of questionnaire (one for divisional managers and the other their immediate superiors) were prepared and pilot-tested. During the interview the superior questionnaire was given to each senior manager for completion, and the subordinate questionnaires were also handed to the senior managers for distribution to their immediate subordinate managers. Both sets of questionnaires contained questions regarding the performance of the subordinate managers (see Appendix A). Responses to the superior and subordinate questionnaires provided the ratings data for the purpose of this study. Confidentiality of all responses was assured. Questionnaires were returned directly by the individual managers to this researcher using the self-addressed and prepaid envelopes provided.

ANALYSIS OF RESPONSES

A total of 108 subordinate questionnaires and 23 superior questionnaires were distributed to 21 companies contacted by letter or telephone. Questionnaires returned consisted of 81 from division managers and 18 from their immediate superiors, giving response rates of 75 percent and 78 percent respectively. Of the 81 subordinate questionnaires received, 78 were fully completed and useable, and 64 of these could be matched with responses to the superior questionnaires. In other words, a total of 64 pairs of self-ratings and superior-ratings were obtained.

RESULTS AND DISCUSSION

LENIENCY ERRORS

TABLE 1. Means, Standard Deviations and Tests for Leniency Effects

	Self-Rating		Superior-Rating	
	Mean	SD	Mean	SD
Planning	5.74*	0.82	5.45	1.01
Investigating	5.38	1.15	5.09	1.02
Coordinating	5.64**	1.06	5.11	1.06
Evaluating	5.48*	1.15	5.20	0.84
Supervising	6.05**	0.84	5.45	0.92
Staffing	5.61**	0.99	5.16	0.82
Negotiating	5.61	1.06	5.4	0.78
Representing	4.72	1.46	4.86	1.10

Tests of mean differences: * $p<.05$ ** $p<.01$

Table 1 presented the means and standard deviations for the eight performance dimensions. In seven out of eight mean values, manager-ratings were higher than superior-ratings. Paired t-tests for correlated samples yielded significant differences for planning, coordinating, evaluating, supervising and staffing. These results suggested that leniency effects do exist in performance ratings, with manager-ratings tending to be more lenient than superior-ratings.

MTMM ANALYSIS

Table 2 presented the MTMM matrix which provides three types of information. First, it shows the correlations between measures of different performance traits assessed by each rating method. These are represented by the triangles in the upper left for self-ratings and lower right for superior ratings, described as monomethod-heterotrait triangles. Second, MTMM shows the correlations between measures of different performance traits assessed by different rating methods. These are represented by the square matrix (lower left), which is the heteromethod-heterotrait block. Third, MTMM shows the correlations between measures of the same trait assessed by different rating methods. These are termed heteromethod-monotrait values, and are indicated by the circled values along the diagonal of the square matrix.

HALO EFFECTS

TABLE 2. Multitrait- Multimethod Matrix for Managerial Performance Appraisals

Method		Self-Rating										Superior-Rating								
		1	2	3	4	5	6	7	8	9		1	2	3	4	5	6	7	8	9
Self-Rating	1																			
	2	33																		
	3	37	46																	
	4	30	49	66																
	5	50	21	48	40															
	6	43	23	36	29	59														
	7	54	31	47	34	52	59													
	8	35	12	20	33	41	35	53												
	9																			
Superior-Rating	1	-21	-22	-04	00	-06	-14	-13	02		:									
	2	-12	-15	02	-03	-04	-06	-01	-01		:	50								
	3	-18	00	-06	-11	-13	-11	-16	-26		:	52	12							
	4	02	00	10	08	08	00	02	-26		:	40	40	39						
	5	07	04	04	00	07	02	00	-07		:	39	04	63	51					
	6	21	-12	18	07	20	14	22	12		:	39	44	24	48	45				
	7	07	04	10	09	06	11	12	07		:	12	04	09	26	20	05			
	8	-01	-07	-03	-02	04	-04	10	12		:	06	10	07	04	03	27	23		
	9																			

Note: Decimals are omitted: figures within dotted lines belong to heterotrait-heteromethod triangles:Others represent heterotrait-monomethod triangles.

(1) Planning (2) Investigating (3) Co-ordinating (4)Evaluating (5) Supervising (6) Staffing (7) Negotiating (8) Representing (9) Overall Effectiveness

The possibilty of halo effects was tested by comparing the intercorrelations among performance dimensions for manager- and superior-ratings. There were

28 intercorrelations in each of the monomethod-heterotrait triangles in Table 2, resulting in 28 pairs of comparisons (manager-rating vs superior-rating). In 21 of the 28 comparisons, the intercorrelation for manager-ratings exceeded the corresponding intercorrelation for superior-ratings. Sign test showed that this was significant at $p<.004$, indicating substantial halo effect for manager-ratings.

CONVERGENT VALIDITY

Since convergent validity is evidenced by the correlations between the same performance dimension assessed by different rating groups, this is demonstrated by the validity diagonal entries (circled) of the square matrix which must be positive and significantly different from zero. Table 2 showed that the manager- and superior-ratings did not appear to agree significantly on the validity diagonal to satisfy the condition for convergent validity. Three of the correlations shown on the validity diagonal were in fact negative, and the remaining correlations were quite small. Given that the convergent validity coefficients were not substantially higher, this meant that the performance traits were correlated, and there was a method bias or halo effect.

DISCRIMINANT VALIDITY

Two different aspects of discriminant validity are particularly relevant to the present study. First, discriminant validity is evidenced by the correlations in the validity diagonal which should be higher than those correlations in the same column and row in the heteromethod-heterotrait block. In other words, the validity diagonal correlations should be higher than those between different traits assessed by different methods. This test required that each of the 8 convergent validity coefficients was compared with each of the 14 other coefficients, giving a total of 112 possible comparisons. Analysis yielded 69 comparison correlations which met this criterion. A sign test for each performance dimension showed that the number of times the validity coefficient was higher than the appropriate row-column correlations was statistically significant ($p<.05$) for the following performance dimensions: evaluating, supervising, negotiating and representing. The results based on this criterion thus provided partial support to the claim of discriminant validity.

Second, discriminant validity is also demonstrated when the validity diagonal coefficients are higher than those correlations in the monomethod-heterotrait triangles. In other words, discriminant validity exists when the correlations between different measures of the same trait exceed the correlations of different traits by the same methods. For the self-rating method, the validity coefficients were larger in only one out of 56 possible comparisons, and a sign test for each performance dimension revealed the comparisons were not significant for any dimension. For the superior-rating method, 12 out of 56 possible comparisons met the criterion. Again, using a sign test, it was found that the comparisons were not significant for any dimension. Since the results based on the second criterion showed no evidence of discriminant validity, there was a strong possibility that the relationship found between different performance traits as rated by each rater group could be ascribed to the data collection method rather than to any true relationships among the dimensions under consideration. A probable source of this method variance in the present study would be a halo effect, which might have contributed to blurring of the distinctions among the performance dimensions.

CONCLUSION

This study reported the results of a comparison of self- and superior-ratings of divisional level managers in selected Australian manufacturing companies. The comparisons focused on four psychometric properties: leniency errors, halo effects, convergent validity and discriminant validity. Statistical analyses showed that significant differences exist between the managers' and their superior's ratings in terms of these criteria. For leniency errors, this study found manager-ratings tended to be more lenient than superior-ratings. For halo effects, again substantial halo effects for manager-ratings were noted. In the case of convergent validity, the results indicated no significant agreement between manager- and superior-ratings, suggesting evidence of method bias. Concerning discriminant validity, overall results indicated that this requirement was not fully met, although in one test, there was partial support for discriminant validity. The findings from this study provided further evidence on the performance ratings issue and suggested that the exclusive use of the self-rating method in performance evaluation research should be approached with caution. The lack of conclusive evidence however provided an opportunity for further research in different settings and at different organizational levels.

Appendix 1

SUBORDINATE QUESTIONNAIRE

Managerial Performance

Listed below are EIGHT management functions. Two questions are addressed in relation to EACH of them:

(i) How IMPORTANT is the management function compared with the overall duties of your present job?

(ii) To what EXTENT do you believe you have met your superior's expectation of your performance in carrying out this function?

(Please CIRCLE the relevant NUMBER on EACH of the 7-point scales below)

(a) PLANNING: Determining goals, policies, and courses of action. Work scheduling, budgeting, setting up procedures, setting goals or standards, preparing agendas, programming.

Little or no Importance	1 2 3 4 5 6 7	Very Important
Least Extent	1 2 3 4 5 6 7	Great Extent

(b) INVESTIGATING: Collecting and preparing information, usually in the form of records, reports, and account inventorying,measuring output, preparing financial statements, recordkeeping, performing research, job analysis.

Little or no Importance	1 2 3 4 5 6 7	Very Important
Least Extent	1 2 3 4 5 6 7	Great Extent

(c) COORDINATING: Exchanging information with people in the organisation other than subordinates in order to relate and adjust programs. Advising other departments, expediting liaision with other managers, arranging meetings, informing superiors, seeking other departments' cooperation.

Little or no Importance	1 2 3 4 5 6 7	Very Important
Least Extent	1 2 3 4 5 6 7	Great Extent

(d) EVALUATING: Assessment and appraisal of proposals or of reported or observed performance. Employee appraisals, judging output records, judging financial reports, product inspection, approving requests, judging proposals and suggestions.

Little or no Importance	1 2 3 4 5 6 7	Very Important
Least Extent	1 2 3 4 5 6 7	Great Extent

(e SUPERVISING: Directing, leading, and developing subordinates. Counselling subordinates, training subordinates, explaining work rules, assigning work, discipling, handling complaints of subordinates.

Little or no Importance	1 2 3 4 5 6 7	Very Important
Least Extent	1 2 3 4 5 6 7	Great Extent

f) STAFFING: Maintaining the work force of a unit or of several unit. College recruiting, employment interviewing, selecting employees, placing employees, promoting employees, transferring employees.

Little or no Importance	1 2 3 4 5 6 7	Very Important
Least Extent	1 2 3 4 5 6 7	Great Extent

g) NEGOTIATING:Purchasing, selling, or contracting for goods or services. Tax negotiations, contacting supplies, dealing with sales representatives, advertising products, colooctives, advertising products, collective bargaining, selling to dealers or customers.

Little or no Importance	1 2 3 4 5 6 7	Very Important
Least Extent	1 2 3 4 5 6 7	Great Extent

(h) REPRESENTING: Advancing general organisational interests through speeches, consultation, and contacts with individuals or groups outside the organisation. Public speeches, community drives, news releases, attennding conventions, business club meetings.

Little or no Importance	1 2 3 4 5 6 7	Very Important
Least Extent	1 2 3 4 5 6 7	Great Extent

2 To what EXTENT do you believe your superior's expectation of your OVERALL performance has been met in managing your division/department?

SUPERIOR QUESTIONNAIRE
Managerial Performance of Subordinate

Listed below are EIGHT management functions. How SUCCESSFUL do you think your SUBORDINATES is when carrying out EACH of these functions?(Please circle the relevant NUMBER on each of the 7-point scales below)

Name of Company: ....
Name of subordinate's division: ....

(1) PLANNING: Determining goals, policies, and courses of action. Work scheduling, budgeting, setting up procedures, setting goals or standards, preparing agendas, programming.

Very Unsuccessful 1__ 2__ 3__ 4__5__ 6__ 7 Very Successful

(2) INVESTIGATING: Collecting and preparing information, usually in the form of records, reports, and accounts inventorying, measuring output, preparing financial statements, recordkeeping, performing research, job analysis.

Very Unsuccessful 1__ 2__ 3__4__ 5__ 6__ 7 Very Successful

(3) COORDINATING: Exchanging information with people in the organisation other than subordinates in order to relate and adjust programs. Advising other departments, expediting liaision with other managers, arranging meetings, informing superiors, seeking other departments' cooperation.

Very Unsuccessful 1__ 2__ 3__4__ 5__ 6__7 Very Successful

(4) EVALUATING: Assessment and appraisal of proposals or of reported or observed performance. Employee appraisals, judging output records, judging financial reports, product inspection, approving requests, judging proposals and suggestions.

Very Unsuccessful 1__ 2__ 3__4__ 5__6__7 Very Successful

(5) SUPERVISING: Directing, leading, and developing subordinates. Counselling subordinates, training subordinates, explaining work rules, assigning work, discipling, handling complaints of subordinates.

Very Unsuccessful 1__2__ 3__ 4__5__ 6__7 Very Successful

(6) STAFFING: Maintaining the work force of a unit or of several units. College recruiting, employment interviewing, selecting employees, placing employees, promoting employees, transferring employees.

Very Unsuccessful 1__2__ 3__4__ 5__ 6__7 Very Successful

(7) NEGOTIATING: Purchasing, selling, or contracting for goods or services. Tax negotiations, contacting suppliers, dealing with sales representatives, advertising products, collective bargaining, selling to dealers or customers.

Very Unsuccessful 1__2__ 3__ 4__ 5__6__ 7 Very Successful

(8) REPRESENTING: Advancing general organisational interests through speeches, consultation, and contacts with individuals or groups outside the organisation.

Public speeches, community drives, news releases, attennding conventions, business club meetings.

Very Unsuccessful 1__ 2__ 3__4__5__ 6__ 7 Very Successful

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Teoh Hai Yap
School of Accountancy & Business
Nanyang Technological University,
Nanyang Ave., Singapore 2263