

# Futures options and their use by financial intermediaries

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Since the fall of 1982, futures exchanges in the United States have been allowed to trade options on futures contracts. These new option contracts give the option holder the right, but not the obligation, to buy or sell a futures contract at a specified price until a fixed future date. Currently, 25 futures option contracts are traded: ten agricultural contracts, five contracts on gold and silver futures, and ten contracts on foreign currencies, debt instruments, and stock indices. The five largest option contracts with respect to the total number of contracts outstanding are: Treasury bond futures (Chicago Board of Trade), soybean futures (Chicago Board of Trade), corn futures (Chicago Board of Trade), gold futures (Commodity Exchange), and West German Mark futures (Chicago Mercantile Exchange).<sup>1</sup>

At this stage in the development of futures option markets, options on financial futures dominate the trading activity. Because financial futures options represents a potentially useful method to control the risks of financial intermediary operation, this article discusses the principal aspects of financial futures options and the settings in which financial intermediaries can use them.

Specifically, this article begins with a review of the institutional features of option trading. The different types of options, and their profitability at maturity are discussed, as well as the properties of option pricing. The next section considers the social value of options markets and compares option contracts with futures contracts as a risk management tool. Futures option trading is then applied to the management of three different kinds of financial intermediary risk exposure. Information is also presented on the frequency of use of option arrangements by commercial banks in the United States. Following that, a discussion of several regulatory considerations with respect to futures options, in general, and the use of futures options by financial intermediaries, in particular, concludes the article.

## Features of option trading<sup>2</sup>

The chief distinction between an option contract and either a futures or a forward contract lies in the obligations of the contract holder. Both futures and forward contracts obligate the buyer (long) to purchase and take delivery of the underlying instrument or commodity if the contract is held to expiration. To do otherwise is to default on the contract. The buyer of an option, however, is not legally obliged to take any further action over the life of the contract once the option has been purchased. If the option is not exercised at or prior to expiration, the option seller or writer (short) is also freed of all contractual obligations.

Depending on whether the option buyer has the right to buy or sell the underlying instrument or commodity, two different types of option contracts exist; these are calls and puts, respectively. Anyone can either buy or write either of these two option types, and for every call or put there must be both a buyer and a writer to complete the transaction.

The market price at which a call or put option contract is sold is called the premium. It is paid by the buyer to the writer of the option in full. A complete specification of an option contract includes: the option type (call or put), the underlying instrument or commodity, the number of underlying units optioned, the expiration or maturity date of the option, the price at which the long can exercise the option rights (exercise or strike price), and the rule for exercise (either American or European). An American option can be exercised at any time after purchase; European options can only be exercised at the maturity date.

With futures options, many of the above contract specifications are standardized to facilitate contract offset. At each futures exchange, a clearing association interposes itself

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between the option buyer and writer to substitute the association's default risk for the default risk of the contract principals. Because of contract standardization and the operation of a clearing association, a buyer of a call option, for example, can exit the option market by writing a call on the same option contract. Therefore, an option long has three alternatives to exit the market: let the option expire unexercised, exercise the option at or prior to maturity, or sell the same option prior to maturity. A buyer of a call (put) that exercises the option receives a long (short) futures position; a seller of a call (put) that is assigned for exercise takes a short (long) futures position.

Financial futures options are traded with three expiration dates three months apart, the longest maturity being nine months forward. All are traded on a March-June-September-December cycle. Depending on the market on which the option is traded, the last option trading day is either the expiration date of the underlying futures contract or approximately three weeks prior to expiration of the futures contract. The strike or exercise prices of the options in a futures contract bracket the current price of the underlying contract at discrete intervals; as the futures price fluctuates, additional exercise prices are opened for trading by the exchange. All futures options traded in the United States can be exercised prior to maturity (American options). Each option also corresponds one-for-one with an underlying futures contract.

Table 1 shows an example of the report of the trading on the Chicago Board of Trade's Treasury bond futures option market. Option prices are reported by exercise price, option type, and maturity. Premiums in this example refer to the last futures option trade of the day. Financial futures option premiums are quoted in one of two ways. For debt instruments and index futures options, premiums are described in points and valued in dollars. In foreign currency futures options, premiums are quoted and valued in dollars. In Table 1, for example, the premiums on the September call and the March put, both with an exercise price of 72, are \$4,000 and \$2,328, respectively (1 point = \$1000).

As mentioned above, once an option position has been taken, three actions are available: permit option expiration, option exercise, or option offset. To study the desirability of

each of these actions, suppose an investor owns a Treasury bond futures call option with a strike price of 75 and it is the option expiration day. If the call is exercised, the investor acquires a long Treasury bond futures contract valued at \$75,000. If Treasury bond futures contracts are trading for any price less than 75, exercising the call creates a loss. It would be better to let the option expire unexercised and purchase the Treasury bond futures contract directly. In general, the value of a call option is zero at expiration if the price of the underlying instrument is less than the option strike price. Therefore, the investor also does not benefit from an option offset trade (writing a call on the same option) because the premium is zero.

If the underlying Treasury bond futures price is above the call option strike price at expiration, say at 80, the investor can exercise the call option and sell Treasury bond futures at a price \$5000 greater than \$75,000, the price of the long futures position acquired through the option exercise. The value of the call option at expiration is therefore equal to the difference (\$5000) between the price of the underlying futures and the option strike price; permitting the option to expire results in a lost profit opportunity.

If the option premium is trading at greater than \$5000 at expiration, the investor can offset the call position by selling or writing a call on the same option, earning the excess of the call premium over the underlying futures price less the option strike price. Similar actions by other long calls and arbitrageurs will drive the call option premium back to \$5000. If the call option premium is trading at less than \$5000 at expiration, option offset is not profitable and additional call buyers will enter the market to bid away the excess of \$5000 over the call option premium. In the end, the actions of market participants force the call option price to exactly equal the difference between the underlying futures price and the option strike price, at expiration. The same argument applies to futures put options.

If the present price of the futures contract is above (below) the strike price of the call (put) option, it is called an in-the-money option; if the present price of the futures contract is below (above) the strike price of the call (put) option, it is called an out-of-the-money option. The intrinsic value of an option is the amount

**Table 1**  
**Treasury bond futures option prices**  
**June 24, 1985**  
**\$100,000 face value; prices in points and 64ths of 1%**

Strike Price	Calls-Last			Puts-Last		
	Sept	Dec	Mar	Sept	Dec	Mar
72	4-00	3-57	3-51	0-30	1-24	2-21
74	2-37	2-50	2-53	0-63	2-12	3-13
76	1-31	1-55	2-02	1-53	3-20	4-20
78	0-51	1-14	1-28	3-05	4-34	5-39
80	0-24	0-48	—	4-39	6-00	—
82	0-11	0-30	—	6-25	—	8-40

SOURCE: *Wall Street Journal*, June 25, 1985

by which the option is in the money. Therefore, the intrinsic value of an out-of-the-money option is zero. But prior to expiration, the option premium consists of more than just its intrinsic value; it also includes a time value.

The time value of an option is the seller's compensation for the possibility that the option will be worth more at maturity than if exercised immediately. Therefore, out-of-the-money options prior to maturity trade at positive premiums, solely reflecting the option's time value. The premium rewards the option writer for the risk that the underlying futures price will change and create an in-the-money option. Of course, in-the-money options prior to maturity also have a time value; it is the difference between the option premium and the intrinsic value of the option. In sum, the most interesting question in option trading is how options are priced prior to maturity. The pricing of options has implications not only for the individual market participant but also for the social value and economic impact of these markets.

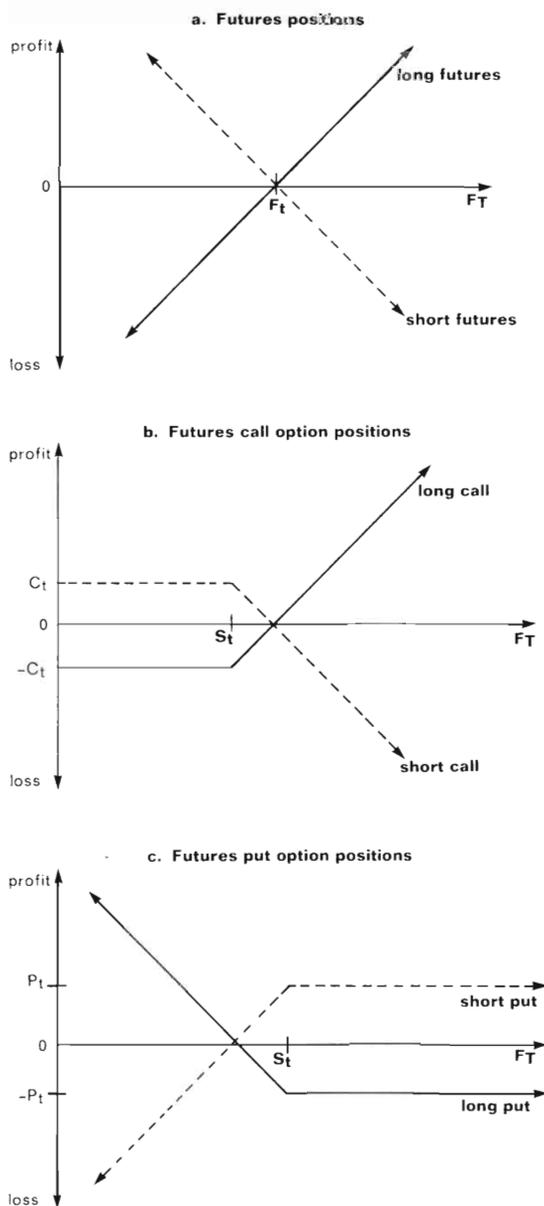
**Profit diagrams** show the profits at expiration from option positions as functions of the underlying instrument's price. They are a simple way to become familiar with options and option strategies provided one considers only options with the same expiration date. Trading commissions are usually ignored to focus on the profit outcome of the option strategies. Further, you should suppose that the only instruments available to the investor are futures option puts and calls on the same futures con-

tract and the futures contract itself. Three simple strategies are discussed: naked (uncovered) positions, hedged (covered) positions, and spread or straddle positions.

**Naked positions** involve only one of the three investments, taken alone. The investor can either buy or sell futures, futures call options, or futures put options. Figure 1 shows the profit diagrams for each of these actions. The trading profit is shown as a function of the different possible values of the futures price at option expiration,  $F_T$ , given that the position was established either at a futures price at time  $t$  ( $t < T$ ) of  $F_t$  or a futures option exercise price of  $S_t$ . In Figure 1a, increases in the futures price over  $F_t$  increase (decrease) investor profits from a long (short) futures position dollar-for-dollar as  $F_T$  exceeds  $F_t$ . The maximum loss (gain) on the long (short) futures position occurs when  $F_T$  goes to zero.

In Figure 1b, the long call yields profits similar to the long futures position if the option expires in the money ( $F_T > S_t$ ). If it expires out-of-the-money, however, the maximum loss from the long call is limited to the call premium,  $C_t$ . On the other hand, the maximum gain from writing a call is the same call premium; this occurs when the option expires out-of-the-money ( $F_T \leq S_t$ ). The call writer's losses are potentially unlimited if the call expires in-the-money. It can also be seen from this figure that the simultaneous purchase and sale of a call option at the same strike price reduces profits to zero for all values of  $F_T$ . Gains

Figure 1  
Profit diagrams for naked positions



and losses for the long call are exactly matched by losses and gains for the short call. Like the futures market, the futures option market is a zero-sum game.

In Figure 1c, the long put is seen to yield profits similar to a short futures position except that losses are now limited to the put premium,

$P_t$ . If the long put expires in-the-money ( $F_T < S_t$ ), the maximum profit occurs when  $F_T$  goes to zero and this equals the maximum profit from a short futures position less the put premium paid. The profit from a short put is at a maximum when the put expires out-of-the-money and it equals the put premium. Although the gain is truncated when compared with a long futures position, the maximum loss from a short put is the same as for a long futures position. Finally, note that in Figures 1b and 1c, a long option can have intrinsic value (be in-the-money) and still be unprofitable when exercised. This is because the amount by which the option is in-the-money may not cover the premium paid to the option writer. Nevertheless, the long will always want to capture an option's positive intrinsic value at expiration in order to minimize losses.

**Hedged positions** in this simple menu of investments involve a combination of the underlying futures contract and one or more options of the same type. The combination of investments is undertaken to manage the risks inherent in a naked position. One common hedge strategy is to write covered call options. Figure 2a shows the profit diagram for hedging a long futures position with a short call assuming, for simplicity, that the option strike price,  $S_t$ , equals the initial futures price,  $F_t$ . This hedging strategy converts all profitable futures price changes into a constant return of  $C_t$ , the call option premium. Unfavorable futures price changes are mitigated by the receipt of the call premium.

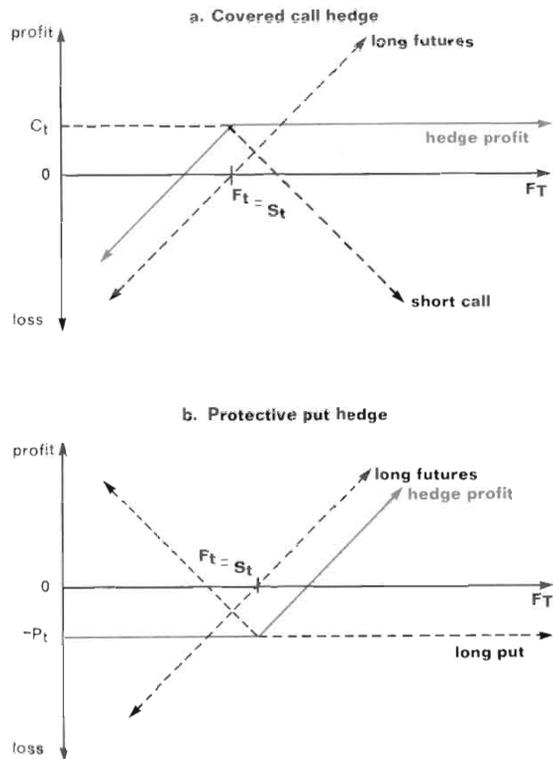
This strategy can be used to increase portfolio returns when futures prices are relatively stable or move only slightly higher. Further, notice that the profit diagram for a covered call hedge is identical to that for a short put option (see Figure 1c). This technique of fabricating put options from a covered call hedge is called a synthetic put or conversion. In Figure 2b, the hedge strategy is to buy protective puts. A long futures position is combined with a long put option to limit the downside risk to the price of a put option. If futures prices rise, the cost of the out-of-the-money put option can be regarded as the cost of insurance for a potential futures loss. The protective put hedge has an identical profit profile at expiration as a long call option (see Figure 1b).

In each of these simple hedging strategies, the selection of the option to be written or purchased is important in allowing the investor to capture more or less of the favorable outcomes of the underlying futures contract. In Figure 2a, for example, an investor could seek to profit from an increase in futures prices in addition to the option premium earned by writing out-of-the-money call options ( $S_t > F_t$ ). The premium earned on an out-of-the-money option will be smaller than  $C_t$  in Figure 2a so the unfavorable long futures outcomes are improved less by its receipt. With this strategy constant hedge profits at expiration set in at a higher expiration price,  $F_T$ , expanding the range of futures price advances that increase portfolio returns. Similarly, out-of-the-money puts could be purchased in the protective put hedging strategy to decrease the insurance against a futures price fall and capture hedging profits at smaller  $F_T$  than in Figure 2b.

Another method of changing the risk-reward characteristics of covered hedges is to invest in fewer or more options than the number of futures contracts purchased. As fewer (more) calls are written in the covered call hedge strategy, the profit diagram in Figure 2a looks more (less) like the profit diagram for a naked long futures position and less (more) like that for a written futures put option.

**Spread positions** with the same three instruments involve a combination of options with different strike prices or expirations in which some options are held long and some short. A commonly used spread is called a money or vertical spread where the options have the same expiration date but different strike prices. Figure 3a and 3b illustrate the profit diagrams for two possible money spreads: a bear call spread, and a bull put spread. In Figure 3a, a call option has been written with a relatively low strike price,  $S_t^l$ , earning a premium of  $C_t^l$ , and another call option has been purchased with a relatively high strike price,  $S_t^h$ , at a cost of  $C_t^h$ . This spread is termed a bear call spread because it shows a profit (loss) when the long futures position has unfavorable (favorable) outcomes. If both options expire out-of-the-money ( $F_T < S_t^l < S_t^h$ ), the maximum profit is the difference between the premium earned on the short call,  $C_t^l$ , and the cost of the long call,  $C_t^h$ . The maximum loss from the bear call spread, which occurs if both options expire in-

Figure 2  
Profit diagrams for hedge positions



the-money ( $S_t^l < S_t^h < F_T$ ), is equal to the position value at expiration  $((S_t^h - F_T) - (S_t^l - F_T) = S_t^h - S_t^l)$  plus the excess of the premium received over the premium paid ( $C_t^l - C_t^h$ ). If  $S_t^l > F_T > S_t^h$ , then the long call position will expire unexercised and profits will fall with the short call position. In general, a bear call spread is profitable if futures prices fall.

Figure 3b illustrates a money spread that is profitable if futures prices rise, called a bull put spread. It involves writing a put option with a high strike price and buying a put option with a low strike price. The maximum profit from a bull put spread, which occurs when both options expire out-of-the-money ( $S_t^l < S_t^h < F_T$ ), is equal to the excess of the premium earned over the premium paid,  $P_t^h - P_t^l$ . The maximum loss occurs when both put options expire in-the-money ( $F_T < S_t^l < S_t^h$ ). The losses from the short put are offset somewhat by the gains from the long put. The maximum loss is equal to  $(F_T - S_t^h) -$

$$(F_T - S_t^l) = S_t^l - S_t^h \text{ less the premium difference, } P_t^h - P_t^l.$$

Yet another type of options-only strategy is shown in Figure 3c. This combination of options involves buying both a call and a put option with the same strike price and exercise date, called a purchased straddle. This type of strategy will be profitable in a highly volatile futures market where the possibility exists of either a large futures price fall or a large futures price rise. Figure 3c illustrates the situation of in-the-money call options and out-of-the-money put options ( $C_t > P_t$ ). The maximum loss from a purchased straddle ( $C_t + P_t$ ) occurs when the futures price at expiration is at the strike price of the options. Other types of

straddles can be created and it is left to the reader to draw the profit diagram for a written straddle.

### Social value of option markets

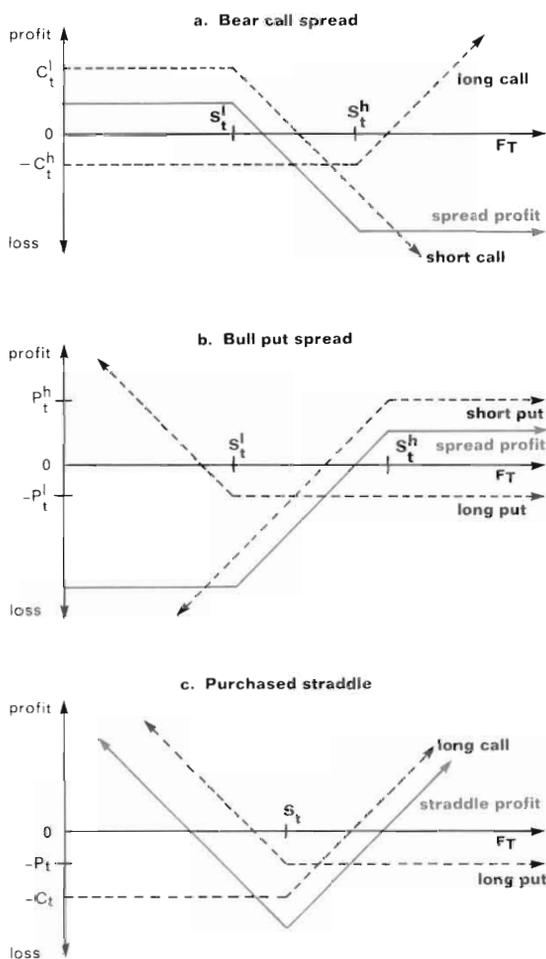
At this point it would be useful to discuss the economic benefits of futures and option markets (derivative markets) and their effect on the allocation of resources. Perhaps the most important economic function served by derivative markets is that they provide a means to transfer risk exposure encountered in business operations or investing to those more willing to bear the risk. These markets are beneficial to society because they expand the scope of possible risk management activities. To the extent that businesses can shed some of their risks with these contracts, resource allocation decisions can be made with less uncertain outcomes.

Derivative markets may also reduce the overall level of risk exposure in the economy provided hedgers willing to sell contracts are trading with hedgers willing to buy contracts. The resulting swap of risk exposure between hedgers makes each less risky. However, the risk transfer benefits of derivative markets are lessened to the extent that cash and derivative market prices fail to move together (basis risk).

A second economic function performed by the futures and options markets deals with the forward pricing and price discovery process. Currently available information will be used by hedgers and speculators in establishing derivative contract positions; thus, market prices will reflect current and prospective demand-supply conditions in the underlying instrument. Of course, this result requires market participants to be efficient and accurate processors of information. If they are, derivative market prices could be used by non-participants to base transactions in "off-exchange" markets, further aiding the allocation of resources.

A third general economic function of derivative markets is to increase the liquidity of underlying cash markets. The mechanism linking cash and derivative markets is the activity of hedgers, arbitrageurs, and spreaders. For example, a bank might decide to increase its fixed-rate lending funded by variable-rate deposits when it utilizes the risk-shifting potential of derivative markets. Because of joint cash and derivative market decisions, liquidity tends

Figure 3  
Profit diagrams for spread positions



to be enhanced in both markets; execution costs are reduced over transactions made without derivative markets.

There are also benefits specific to options, in general, and futures options, in particular, that are not available with futures alone. As is obvious in Figure 1, above, the risk-reward trade-off for futures options is significantly different than for futures. Losses and gains can be limited with options depending on the type of option traded; options can be used to provide insurance against unfavorable outcomes of the underlying instrument while retaining the favorable outcomes. This is not possible with futures because favorable (unfavorable) outcomes of the underlying instrument are generally offset by unfavorable (favorable) outcomes of the futures. This makes options a more suitable hedging device than futures for the management of quantity, as opposed to price, risks.

Quantity risks are associated with potential transactions that may or may not take place. Quantity risk tied to interest rate movements, such as takedowns on fixed-rate loan commitments, can be hedged by purchasing financial futures options and, if the contingency underlying the quantity risk is realized, exercising them. If the contingency is not realized, the option is permitted to expire and the cost of the premium is just the cost of insurance. As Figures 2 and 3 show, options can also be used to customize the risk-reward trade-off according to the risk preferences of the investor. By creating portfolios of options and the underlying security with different strike prices and expiration dates, a whole menu of portfolio return characteristics can be offered. Options are more flexible than futures in this sense. Finally, except for naked written options, the options investor is not subject to any margin calls over the life of the option. Once the option premium is paid, the investor does not risk being forced out of a position by maintenance margin calls, as is possible in futures trading.

But what advantage is there to trading futures options instead of options on cash market financial instruments?<sup>3</sup> Currently, both options on futures and options on actuals are actively traded for the same financial instruments; both serve very similar functions in facilitating the allocation of resources. Nevertheless, there are reasons why futures options might survive this derivative market redundancy. In some cases, the volume of

trade and liquidity of the underlying futures market exceeds that of the underlying actuals market. If the options are exercised, a liquid market facilitates the exit from or adjustment to the position acquired in the underlying instrument. For example, the deliverable supply of Treasury bond futures contracts is virtually limitless, unlike the deliverable supply of a specific Treasury bond issue.

Financial futures options also avoid the adjustment needed at exercise to compensate for accrued coupon or dividend payments on the underlying instrument. This is not true of options on cash Treasury bonds. Furthermore, unlike options on actuals, an exercise of a futures option does not require payment or receipt of the entire cash value of the underlying instrument implied by the option strike price. All that is needed is that the payment be the incremental futures margin to cover any gain or loss due to the difference between the current futures price and the exercise price. This reduces the capital requirement for option trading and extends the possibilities for leverage.

It may also be easier to price options on futures than options on actuals prior to expiration because futures prices are more readily available than actuals prices. In any event, the ease with which one can speculate on either the long or the short side of futures markets, unlike most actuals markets, creates a demand for risk-limiting tools like futures options for futures participants.

### The pricing of futures call options

In 1976, Fischer Black derived a formula for calculating the theoretical price of a call option on a futures contract prior to expiration.<sup>3</sup> This formula shows the basic variables that a futures option investor needs to know before an estimate can be formed of what a particular option price should be. The different types of variables fall into one of three groups: variables associated with the underlying futures contract, variables associated with the option itself, and variables that are exogenous to the pricing decision. Black's formula for a futures call option is given by

$$C_t = e^{-r(T-t)} [F_t \cdot N(d_1) - S_t \cdot N(d_2)]$$

where:  $d_1 = [1n(F_t/S_t) +$

$(1/2)\sigma^2(T-t)]/\sigma(T-t)^{1/2}$ , and

$$d_2 = d_1 - \sigma(T-t)^{1/2},$$

and the new notation is

$e$  = the exponential function,

$r$  = the risk-free interest rate,

$N(i)$  = the cumulative normal density function evaluated at  $i = d_1, d_2$ ,

$\ln$  = the logarithmic function, and

$\sigma$  = the standard deviation of the futures price.

Black derived this formula by first assuming that the futures price change can be described by a log-normal distribution with known variance, all the parameters of the capital asset pricing model are constant through time, and taxes and transaction costs are zero.<sup>4</sup>

Of the variables relating to the underlying futures price, the most important is the current price of the futures contract,  $F_t$ . The higher is the underlying futures price, the greater is the value of the call option because of the greater anticipated value of the option at expiration. The volatility or variability of the underlying futures price is another variable in this group. As futures price volatility increases, so does the possibility of favorable or unfavorable outcomes for the futures investor. But for the option investor, only the in-the-money outcomes have an impact on the value of the option. Since the magnitudes of possible favorable outcomes increase with greater futures price volatility, so does the futures call option premium.

Variables in the formula that are associated with the option itself are the option strike price and its time to maturity. Because the strike price influences the value and payoff of a call at expiration, decreasing the strike price will increase the call premium and vice versa (see Table 1). The time to maturity of a given underlying futures contract is important in futures option pricing because as the time to expiration increases, the present value of the exercise price that could be paid at expiration decreases. Also, increasing the time to maturity increases the likelihood of favorable option outcomes during the life of the contract. Call premiums, therefore, increase as time to maturity increases.

A final variable that is assumed exogenous in Black's pricing formula is the risk-free rate of interest. An increasing interest

rate decreases the present value of option profits at expiration; hence, the call premium falls as the risk-free rate rises.

Besides using Black's formula to evaluate whether a given futures option is "expensive" or "cheap", another application of the formula is to use it to derive a riskless hedge ratio.<sup>5</sup> A riskless hedge ratio is the ratio of the number of futures contracts that must be held per futures option to fully insulate the investor against movements in the underlying futures price. Using Black's formula, this hedge ratio,  $h$ , can be shown to be

$$h = -e^{-r(T-t)}N(d_1).$$

That is, a portfolio which includes  $h$  long futures contracts and a written futures option on the same contract leaves the value of this portfolio unchanged on net when the futures price changes. Movements in the value of the option are exactly counteracted by futures price movements and vice versa. The minus sign in the expression for  $h$  indicates that the futures and futures option are held in opposite positions, either long or short. For example, if  $h = -.5$ , a change in the futures price of one point causes the value of a written futures call option to change by .5 points. Therefore, two call options should be written for each futures contract to leave the value of the hedged portfolio unaffected by a change in the futures price. The riskless hedge ratio changes as each of the variables discussed above changes; thus, the riskless hedge ratio must be reevaluated and adjusted frequently over the life of the hedge.

### **Financial intermediaries and financial futures options**

Having described the mechanics of futures options, we are now prepared to discuss the application of financial futures options to depository institution decision-making. This section focuses on the use of futures options to either hedge or limit the risk of bank and thrift operations.

Evidence suggests that financial intermediaries have been even more reluctant to engage in option arrangements than in financial futures. Using Federal Reserve Report of Condition data, a recent study by Parkinson and Spindt shows that no more than 400 domestic commercial banks nationwide reported

**Table 2**  
**Use of option arrangements by U.S. banks, September 1984**

	N	Frequency of use (%)	Ratio of options position to equity (%) <sup>a</sup>
I. Written calls			
a. All U.S. banks	14,489	0.35	17.34 <sup>b</sup> (4.25)
b. Banks with assets less than \$100 million	12,139	0.21	20.83 (6.84)
c. Banks with assets between \$100 million and \$500 million	1,883	0.27	36.40 (22.34)
d. Banks with assets between \$500 million and \$1 billion	198	0.00	0.0 (—)
e. Banks with assets greater than \$1 billion	269	7.45	8.45 (2.62)
II. Written puts			
a. All U.S. banks	14,489	0.39	29.98 (9.02)
b. Banks with assets less than \$100 million	12,139	0.18	47.52 (19.63)
c. Banks with assets between \$100 million and \$500 million	1,883	0.16	12.00 (9.39)
d. Banks with assets between \$500 million and \$1 billion	198	1.01	3.35 (2.20)
e. Banks with assets greater than \$1 billion	269	10.78	20.37 (8.58)

<sup>a</sup> For those reporting a non-zero option position.

<sup>b</sup> Mean with standard deviation in parentheses.

futures and forward market positions as of yearend 1983.<sup>6</sup>

Using Report of Condition data for September 1984, Table 2 shows that option arrangements are reported even less frequently by domestic commercial banks. The data on option arrangements is less than complete since commercial banks are only required to report short call and put option arrangements.<sup>7</sup> Furthermore, these option positions likely include exchange traded, over-the-counter, and personally customized option arrangements. Nevertheless, Table 2 does provide a rough idea of the extent to which commercial banks are engaged in option trading. As of this date, approximately 90 different banks reported written option arrangements, and in this group, banks with assets greater than \$1 billion tend to be the most frequent users.<sup>8</sup>

To highlight the potential uses of financial futures options by banks and thrifts, three

different situations that a financial intermediary might face are discussed. These situations relate to the use of options in 1) a Treasury bond portfolio, 2) interest rate risk management in the financial firm's entire balance sheet, and 3) the management of mortgage prepayment risk. For the sake of simplicity, brokerage commissions and tax considerations are not taken into account.

**Bond portfolio protection.** Suppose that on February 15, 1985, a bond portfolio manager holds 50 Treasury bonds (\$100,000 par value each) with a coupon rate of 10.75% and maturity of February 15, 2003. The manager seeks a strategy to protect the portfolio against rising interest rates and falling bond prices over the next three months. Further, although protecting the value of the portfolio is important the manager would like to retain the opportunity to profit from an increase in bond prices.

The current market yield on these bonds is 11.63% and each is worth \$93,422.

To protect this value the manager decides to buy 50 June 1985 Treasury bond futures put options at a strike price of 72.<sup>9</sup> Since the Treasury bond futures contract is trading at 70.69 on this date, these are in-the-money puts and are priced at \$2,594 each. Three months later on May 17, 1985, the market yield on the bonds in the portfolio has fallen to 11.12%, instead of rising as was feared. Bonds in the portfolio are now valued at \$99,835 each.<sup>10</sup> The cash bond portfolio has appreciated \$6,413 per bond and \$320,650 in total. Since the Treasury bond futures price settled at 73.88 on May 17, 1985, the put options are permitted to expire out-of-the-money.

The net result of this protective put hedging strategy is \$190,950 (\$320,650 minus 50 put option premiums). In contrast, if cash bond rates had risen to 12.14% by May 17, 1985 (or if rates had risen by as many basis points as they actually fell), the bond portfolio would have decreased in value by a total of \$40,550. If the June 1985 Treasury bond futures contract had settled at say, 68.04, the 50 put options would be exercised at a total profit of \$198,000. The net gain to the bond portfolio is \$27,750 (\$198,000 - \$40,550 minus the cost of the purchased puts).

**Asset/Liability management.** Interest rate futures options can be used by a financial intermediary to manage the interest rate maturity gap in its entire balance sheet over a specific time interval in the future. To use futures options in this way, the bank or thrift must first identify the interest rate risk exposure in its balance sheet. The maturity gap approach involves classifying all asset and liability accounts by their term to maturity or first permissible repricing, whichever comes first, and then calculating the dollar difference between assets and liabilities for subintervals in a predetermined horizon.<sup>11</sup> These differences or gaps represent the interest rate risk exposure of the institution at a particular maturity subinterval.

For example, if a hypothetical bank undertook a gap analysis and found that the dollar values of assets and liabilities match at all maturities except those greater than 10 years forward and that, at maturities greater than 10 years forward, a bond investment portfolio similar to the one discussed directly

above had no offsetting liabilities, then the purchase of futures put options would limit the risk of a rise in interest rates and a fall in bond prices.

In this case, managing the risk of a well-defined collection of assets (micro risk management) also reduces the interest rate risk exposure of the entire institution (macro risk management). However, it is not necessarily true that a micro strategy with futures options automatically reduces an institution's entire risk exposure; one must also consider the risk control features of cash items on the other side of the balance sheet with similar maturity or repricing characteristics. In general, a negative maturity gap (rate-sensitive liabilities exceed rate-sensitive assets) can be managed by a strategy of purchasing protective puts.

Alternatively, a financial intermediary could write futures call options to hedge the interest rate risk exposure of a negative maturity gap. The risk-reward tradeoff for a negative gap position looks very similar to the profit diagram for a long futures position (see Figure 1a). If interest rates fall and prices rise, the cost of funding fixed-rate assets declines and the profit margin widens; if rates rise and prices fall, the cost of funding fixed-rate assets increases and the profit margin narrows. Writing futures call options to hedge this risk exposure results in a profit diagram similar to Figure 2a.

For example, suppose that on March 25, 1985, a bank has funded \$75 million in loans that reprice every six months with three-month Eurodollar certificates of deposit at an annual rate of 9.30%. If rates rise by 1%, the bank will have to pay an additional \$187,500 to re-finance the loans. To protect against a rise in funding costs, bank management decides to write June 1985 Eurodollar futures call options at a strike price of 89.50.<sup>12</sup> Since the June Eurodollar futures settled at 89.78 on March 25, 1985, these in-the-money calls earn a premium of \$1,450 each.<sup>13</sup> Assuming bank management believes Eurodollar rates are more likely to fall than rise in three months, only 30 calls are written generating \$43,500 in option premiums.

Roughly three months later, on June 17, 1985, three-month Eurodollar certificates of deposit offer a 7.60% annual interest rate; the bank's loans can now be financed at a savings of \$318,750 relative to the March 1985 rate. On this date the June Eurodollar futures price

settled at 92.44. Because the Eurodollar futures call options have matured and will therefore be exercised, the bank must pay the call buyers \$7,350 ( $= [92.44 - 89.50]2500$ ) for each option or \$220,500 in total. The net savings on the loan refunding is \$141,750 ( $= \$318,750 + \$43,500 - \$220,500$ ).

Of course, if the bank's interest rate risk exposure had been fully covered with 75 written calls, the net savings on the loan refunding would have been negative. Also, if Eurodollar rates had risen 1% instead of fallen over the three-month period, the additional \$107,500 in Eurodollar funding costs would have been partially offset by the receipt of \$43,500 in call premium income.

**Mortgage prepayment protection.** Financial intermediaries that extend fixed-rate mortgage loans funded by short-term liabilities (a negative maturity gap) face two different types of risk associated with interest rate changes: if rates rise, the cost of funding these loans increases and the profit spread narrows and if rates fall, borrowers will refinance their mortgages at lower rates and the profit spread again narrows. Therefore, when a savings and loan association, for example, makes a fixed-rate mortgage loan, it effectively writes a call option over the life of the mortgage for the borrower.<sup>14</sup> It will be exercised when it is in-the-money, i.e., whenever mortgage rates fall below the contractual rate minus any prepayment penalties or new loan origination costs. The savings and loan with a negative maturity gap can manage the risk of a rise in interest rates by either of the methods described directly above: by buying protective puts or writing calls.

To manage the risk of mortgage prepayment if rates should fall, however, the savings and loan should buy interest rate call options. The management of this latter quantity risk is well suited to options trading.

Suppose a hypothetical savings and loan has five homogeneous mortgage loans on its books, each earning a fixed rate of 14.25% with 20 years to maturity on an outstanding principal of \$100,000. These loans are funded with three-month certificates of deposit. On November 15, 1984, conventional mortgages yield 12.3% but because the savings and loan imposes fees and charges of 2.5% on new loan originations, the borrowers find it unprofitable

to exercise their call options. With three-month certificate of deposit rates at 9.2%, the savings and loan earns a 5.05% spread over the cost of funds or \$6,313 every quarter.

To hedge the risk of a fall in mortgage rates and mortgage prepayment, management decides to buy five March 1985 Treasury bond futures call options at a strike price of 70. This strike price roughly reflects the level to which mortgage rates must fall before the borrowers will exercise their call options (11.75%). On November 15, each T-bond futures call option has a premium of \$851 (March 1985 Treasury bond futures = 69.78) and the total option hedge position costs \$4,255. The objective of the savings and loan is, therefore, to protect its spread over the next three months.

On February 15, 1985, mortgage rates have fallen to 11.7% and three-month certificates of deposit earn 8.7% interest. The savings and loan borrowers exercise their call options to refinance at this lower rate; the savings and loan's profit spread narrows to 3% as a result, resulting in earnings of \$3750 every quarter. But the fall in mortgage rates also coincides with a rise in March 1985 Treasury bond futures prices. The five futures call options can be offset to return \$2,109 per option or \$10,545 in total. This return exceeds the cost of the call options plus the loss in quarterly income due to prepayment and refinancing ( $\$4,255 + \$2,563 = \$6,818$ ). Of course, the hypothetical savings and loan has managed the risk of prepayment only over a three-month period and henceforth must deal with the lower yield on its mortgage assets.

## **Regulatory considerations and conclusion**

One justification for this article's treatment of financial futures options as distinctly different from options on cash market financial instruments is the jurisdictional difference in regulatory structures. In December 1981, the Commodity Futures Trading Commission (CFTC) and Securities and Exchange Commission (SEC) made an accord to clarify the jurisdictional responsibilities of the two regulators with respect to financial instrument futures and options. As a result of the accord, which was later codified in the 1982 reauthorization of the CFTC, the SEC is to regulate all options on securities, stock indices, certificates of deposit, and national exchange-traded foreign

currencies; the CFTC is to regulate all futures and futures options on these same instruments as well as an agricultural commodities.

Thus, although options on financial instrument futures and actuals may have the same underlying instrument and, therefore, be highly substitutable in their economic usefulness, two different regulators oversee their trading. To the extent that there are real or philosophical differences in the way these two regulators operate, the markets in options on futures may evolve differently than the markets in options on actuals. This has implications for the long-run survival of one type of option market relative to the other. At this point in their development, it is too early to tell which is the more viable type of financial instrument option.

Another regulatory consideration related to futures options deals with the devices available to protect the financial integrity of the markets. Like other financial markets, futures and futures option markets are subject to the risk that the parties to the transaction will be unable to perform their contractual obligations and default.

Margin requirements and the daily mark-to-market provisions of futures exchange operation are important ingredients for assuring the performance of contractual obligations. Unlike equity margins, futures margins do not reflect a customer's investment in the futures position but merely the deposit of earnest money required to initiate a position and keep it open. The amount of earnest money held by the broker in the customer's account changes due to the daily mark-to-market provisions of exchange operation; as the value of a futures contract position is marked to market and effectively set to zero, all profits and losses are passed through to the respective market participants.

In contrast, futures-type margining is not required on purchases of futures options; option sellers, however, must deposit and maintain margin related to the margin on the underlying futures contract plus the option premium. Since only the futures option seller is obligated to perform over the life of the option, only short option positions are margined. However, any additional margin monies posted by the option seller are not passed through to the option buyer but are held by the seller's broker. The gains on a long put option position in a pro-

ductive put strategy, for example, cannot be used to meet the maintenance margin calls on the futures position as it is marked to market. If a call option seller should fail to meet a margin call as the options move well in-the-money, the option seller's broker could default and the call option buyer may not be able to realize the potential profits from the long option position.<sup>15</sup> In sum, because the profits from a long futures option position are not settled until exercise or offset, the responsibility for financial integrity in futures option markets rests more fully on the exchange clearing associations than on margin requirements and mark-to-market provisions.

Other types of futures option regulation related specifically to financial intermediaries are imposed by the federal bank and thrift regulatory agencies. The following discussion is based just on federal bank regulations.<sup>16</sup> In general, the federal bank regulators disapprove of futures option trading that increases an institution's risk exposure.

The regulators are in agreement, however, that financial futures options can effectively control interest rate risk if properly used and that institutions should use futures options to control only the net interest rate risk exposure in their entire balance sheet. Banks that engage in financial futures options should do so only in accordance with safe and sound banking practices. Furthermore, any trading activity should be at a level reasonably related to the bank's business activity and its capacity to fulfill the contractual obligations. Banks should evaluate their overall interest rate risk exposure resulting from asset and liability positions to ensure that the futures option position reduces its total risk. These policy guidelines are applicable specifically to commercial banking activities and do not pertain to bank trust accounts.

Within these guidelines, some types of option positions are treated specifically by the federal bank regulators. Long-term short option contracts, i.e., those for 150 days or more, are ordinarily viewed as inappropriate for bank trading, unless special circumstances warrant. The regulators believe that such contracts are related not to the investment or business needs of the institution, but primarily to the receipt of fee income or to speculating in future interest rate movements. Moreover, Federal Reserve bank examiners are instructed to treat all na-

ked written call option positions as per se speculative and hence inappropriate.<sup>17</sup> A call option is considered covered only if the underlying instrument to be hedged is deliverable against the option contract. In light of this, the above example of writing call options to manage the net interest rate risk exposure faced by a bank with a negative maturity gap would be considered speculative behavior and contrary to policy guidelines. Because the entire balance sheet must be considered in using futures options, not just a specific instrument, the distinction employed by bank examiners in determining whether a written call is covered or naked is not economically meaningful.<sup>18</sup>

In conclusion, financial futures options provide financial intermediaries with another tool to manage rapidly changing interest rate and quantity risks. The attractiveness and usefulness of financial futures options lies in their versatility; they can be used as a means to limit risk or generate additional portfolio returns even in a stable market environment. For a financial intermediary with a negative maturity gap, the purchase of futures put options allows it to limit risk associated with an increase in interest rates and the sale of a futures call option permits it to lower the variability of its returns. Both strategies result in an institution with reduced exposure to unfavorable interest rate changes. On the other hand, a financial intermediary with a positive maturity gap should either write futures put options or buy futures call options to decrease its interest rate risk. The material presented here is intended as an introduction to futures option contract trading. It will have served its purpose if it helps to educate both the potential users and regulators about the economic usefulness of options on financial futures.

<sup>1</sup> These four contract markets are listed in order, as of September 23, 1985.

<sup>2</sup> The next two sections of the article draw heavily from Robert Jarrow and Andrew Rudd, *Option Pricing*, Homewood, Illinois, Dow Jones-Irwin, 1983, chapters 1-3. Other recent articles on financial futures options include: Laurie S. Goodman, "New Options Markets," *Quarterly Review*, Federal Reserve Bank of New York, Autumn 1983, pp. 35-47; and Michael T. Belongia and Thomas H. Gregory, "Are Options on Treasury Bond Futures Priced Efficiently?" *Review*, Federal Reserve Bank of St. Louis, January 1984, pp. 5-13.

<sup>3</sup> See Fischer Black, "The Pricing of Commodity Contracts," *Journal of Financial Economics*, January/March 1976, pp. 167-179.

<sup>4</sup> For a discussion of the capital asset pricing model, see Michael C. Jensen, "Capital Markets: Theory and Evidence," *Bell Journal of Economics and Management Science*, Autumn 1972, pp. 357-398.

<sup>5</sup> Because Black's model is derived for European options, one may question whether or not the pricing formula given above is applicable to futures options currently traded in the United States. Merton argues, however, that any distinction between European and American options vanishes in the absence of dividends on the underlying instrument. Since futures contracts do not pay dividends (semi-annual coupons), Black's formula is applicable to futures of options. See Robert C. Merton, "The Theory of Rational Option Pricing," *Bell Journal of Economics and Management Science*, Spring 1973, pp. 141-183.

<sup>6</sup> See Patrick Parkinson and Paul Spindt, "The Use of Interest Rate Futures by Commercial Banks," a paper presented at the 21st annual Conference on Bank Structure and Competition, sponsored by the Federal Reserve Bank of Chicago, Chicago, Illinois, May 3, 1985.

<sup>7</sup> This reporting requirement implicitly reveals that if a bank holds an option arrangement instead of writing one, its maximum off-balance sheet risk exposure is limited to the option premium and, hence, does not merit monitoring. If banks attempt to use long option positions to limit or hedge their balance sheet risk exposure, as discussed below, it is currently impossible to tell from the call reports whether or not these options are used properly.

<sup>8</sup> A rough approximation of total put and call option usage (long and short) suggests that fewer than 180 different banks are involved, which is less than half the number of institutions reporting futures and forward contract positions.

<sup>9</sup> In this simple example, no adjustment is made for the difference in coupon yield and maturity of the instrument underlying the Treasury bond futures option (8% coupon, 20-year maturity) and the bonds in the portfolio. The Chicago Board of Trade publishes conversion factors that can be used to convert an actual issue to the hypothetical futures option bond for a match of price sensitivities.

<sup>10</sup> Accrued interest of \$2,688 over three months is included in each of the end-of-period calculations for a cash bond.

<sup>11</sup> For a more detailed discussion of the maturity gap approach to measuring interest rate risk exposure, see Elijah Brewer, "Bank Gap Management and the Use of Financial Futures," *Economic Perspectives*, Federal Reserve Bank of Chicago,

March/April 1985, pp. 12-22; George G. Kaufman, "Measuring and Managing Interest Rate Risk," *Economic Perspectives*, Federal Reserve Bank of Chicago, January/February 1984, pp. 16-29; and Alden L. Toevs, "Gap Management: Managing Interest Rate Risk in Banks and Thrifts," *Economic Review*, Federal Reserve Bank of San Francisco, Spring 1983, pp. 20-35.

<sup>12</sup> Eurodollar futures options (International Monetary Market at the Chicago Mercantile Exchange) began trading on March 19, 1985.

<sup>13</sup> Eurodollar option premium quotations are based on International Monetary Market index points where each index point (.01) represents \$25. June 1985 Eurodollar futures call options with a strike price of 89.50 were valued at .58 on March 25, 1985.

<sup>14</sup> For a discussion of the limitations of using financial futures contracts to hedge this prepayment risk, see Carl A. Batlin, "Interest Rate Risk, Prepayment Risk, and the Futures Market Hedging

Strategies of Financial Intermediaries," *Journal of Futures Markets*, Summer 1983, pp. 177-184.

<sup>15</sup> Recently, just such an episode occurred in the gold futures option market. See articles in *Business Week*, May 27, 1985, pp. 132-134, and the *Wall Street Journal*, March 22 (p. 11) and March 25 (p. 38), 1985.

<sup>16</sup> Because general guidelines issued by the federal bank regulators cover option arrangements, futures contracts, and forward contracts in a single set of documents, see G. D. Koppenhaver, "Trimming the Hedges: Regulators, Banks, and Financial Futures," *Economic Perspectives*, November/December 1984, pp. 3-12, for a related discussion.

<sup>17</sup> See Federal Reserve Board document AD82-24 (FIS): Manual for Examination Concerning Bank and Bank Holding Company Use of Interest Rate Futures and Forward Contracts (July 26, 1982).

<sup>18</sup> This point was first made by Laurie S. Goodman in an unpublished paper entitled "Interest Rate Options and Financial Institutions," Federal Reserve Bank of New York, August 1982.

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