New Options Markets

Wide price swings have been a hallmark of financial markets in recent years. This greater volatility subjected market participants holding traditional assets to unaccustomed risks and increased their demands for instruments designed to shift risk to those better able or more willing to bear it.

This atmosphere has fostered the development of new options markets to reallocate risk These markets offer options on Treasury bonds, notes, and bills, Treasury bond futures, gold futures, foreign currencies, stock indexes, and stock index futures These newly established options markets, while very small at present, are potentially important. They create more flexibility in risk management than is available with existing cash and futures markets. They also provide market participants with a more efficient hedge against some contingencies that they assume in the normal course of their operations.

This article surveys the new options markets—why they have arisen, who is using them, and what purposes they serve It also discusses how these instruments differ from conventional equity options in terms of pricing and other financial characteristics

Risk-return characteristics of options

An option is an agreement between two parties in which one party grants the other the *right* to buy or sell an asset under specified conditions while the counterparty assumes an obligation to sell or buy that asset. The party who must decide whether to exercise the option is termed the option buyer since he must pay for the privilege. The party granting the right to buy or sell an asset is called the option seller or writer of the option There are two basic types of options· calls and puts.

A *call option* gives the buyer the right to purchase, or "call away", a specified amount of the underlying security at a specified price up to a specified date. The price at which the security may be bought is the *exercise price* or the *striking price.* The last date on which the option may be exercised is called the *expiration date* or the *maturity date.* The price of this option contract is its *premium.*

A call option can best be described by means of a simple example. A December call option on Treasury bonds gives the holder of the option the right to purchase $100,000 par value of specified Treasury bonds at a price of $90,000 on or before the expiration date in December[1] The price of these bonds on September 19, 1983 was $90,500. The price of the call option on that date was $2,094. If the market value of the bonds is greater than $90,000 on the expiration date, the option will be exercised The rationale is that, even if the buyer does not want to hold the bonds, they can be resold at the market price. If the market value of the Treasury bonds is less than $90,000 at expiration, the option will not be exercised because the buyer can purchase the bonds at a lower cost in the market.

The price of an option consists of two components—*intrinsic value* and *time value.* The price of an option, if exercised immediately, is the maximum of either zero or the market price minus the exercise price This is called the intrinsic value of the option In the example

[1] In this example, the issue used is the 10⅜ bond due 2007/12 This issue is traded on the Chicago Board Options Exchange

above, the intrinsic value of the option is the $90,500 market price less the $90,000 exercise current price, or $500 An option must always sell for at least its intrinsic value or there will be arbitrage opportunities. Market practitioners call an option with a positive intrinsic value an "in-the-money" option Similarly, an option with zero intrinsic value is known as an "out-of-the-money" option.

The time value of an option is the difference between the premium on the option and its intrinsic value This is the seller's compensation for the possibility that the option will be worth more at the end of its life than if exercised immediately In the example, the time value of the option is the difference between the total price of $2,094 and the intrinsic value, or $1,594.

A *put option* is the right to sell, or "put to" the writer, a given amount of the underlying security at a given price on or before a specific date. In the example above, the Treasury bond December/90 put option gives the buyer the right to sell $100,000 par value of Treasury bonds at a price of $90,000 on or before the expiration date. If the market value of the Treasury bonds is greater than $90,000, the buyer will not exercise the offer, as the bonds can be sold in the open market. If the market value of the bonds is less than $90,000 at expiration, the option to sell the bonds at that price is valuable.

Some market participants purchase options for much the same reason people purchase insurance—they feel the protection they are receiving against adverse developments is worth more to them than the option premium. In the case of the call option example, the buyer of the option is purchasing protection against the price of the bonds rising above $90,000 In the case of the put option, the buyer is purchasing protection against the price of the bonds dropping below $90,000

Other market participants purchase options as a way to speculate on asset price movements Consider an investor who owns a Treasury bond and buys a call on

Table 1

The New Options Markets

Instrument	Options on physicals	Options on futures contracts
Stock indexes	**Chicago Board Options Exchange:** S&P 100 (formerly CBOE 100) S&P 500 S&P integrated international oil group S&P Computer and Business Equipment Index	**Chicago Mercantile Exchange:** S&P 500
	American Stock Exchange: Amex Major Market Index Amex Market Value Index Oil and Gas Index Computer Technology Index	**New York Futures Exchange:** NYSE Composite
	New York Stock Exchange: NYSE Composite Index	
U S Government debt	**American Stock Exchange:** Treasury bills Treasury notes	**Chicago Board of Trade:** Treasury bonds
	Chicago Board Options Exchange: Treasury bonds	
Foreign exchange	**Philadelphia Stock Exchange:** Various currencies*	
Precious metals		**The Commodity Exchange:** Gold
		Mid-American Exchange: Gold†

S&P = Standard & Poor's Corporation

*Canadian dollars, German marks, Japanese yen, Swiss francs, and pound sterling

†Approved, not traded

a Treasury bond future This investor is using the options market to compound his bet that interest rates will fall (bond prices will rise) Similarly, a financial institution which has liabilities of a shorter repricing period than its assets will be favorably affected if interest rates fall and unfavorably affected if interest rates rise. If this institution bought a put option on a debt security, it would clearly be hedging. If it purchased a call option, it would be compounding its current interest rate mismatch

Why do investors write options? Their gain is limited by the premium, while their potential loss is much larger Options writers believe that the premium is adequate compensation for their potential loss. In fact, the premium is the equilibrating price variable, equating the quantity of options supplied with the quantity of options demanded If the option premium were too low to compensate the writer for the risk, there would be more buyers than sellers, forcing the premium to rise.

It is important to realize that option writing need not be speculative. An investor who writes call options on an equity (covered call writing) may perceive himself as hedging, as the option increases his returns in periods of poor and moderately good stock returns and reduces it in periods of very good stock returns. Similarly, if a bank that has liabilities with a shorter repricing period than its assets writes a call option on a bond or bond future, it is actually reducing its interest rate sensitivity. If interest rates rise, the option cushions the portfolio loss as the bank receives the option premium If interest rates fall, the bank receives the premium but trades away some of its potential gain.

New options markets

Prior to 1982, organized markets existed only for options on common stock These equity options are traded on four exchanges: the Chicago Board Options Exchange (CBOE), the American Stock Exchange (Amex), the Philadelphia Stock Exchange, and the Pacific Stock Exchange Put options on the securities of the Government National Mortgage Association were traded on an over-the-counter basis.

Since the last quarter of 1982 many new options markets have opened; others are in the final planning stages (Table 1) These new options are written on four types of financial instruments:

- options on stock indexes
- options on debt instruments
- options on foreign currencies
- options on gold.

The new contracts take two basic forms:

- options on so-called physicals, *i.e.*, actual commodities, securities, or indexes
- options on futures contracts

Market participants

Since these markets are very new, it is difficult to assess who will eventually constitute the customer base. Institutions that are more conservative and less inclined to enter new markets may well turn out to be very large customers once the markets become better established.

Nevertheless, preliminary evidence indicates that the options on stock indexes and stock index futures are dominated by individuals rather than institutions. They are using the market as a method to wager bets on aggregate market movements rather than focusing attention on particular securities. Broker/dealer firms are relatively small users of options on stock indexes for their own account. Institutional money managers are just beginning to enter the market on the buy side as a hedging vehicle for their portfolio and on the sell side as a source of fee income

By contrast, options on debt instruments appear to be dominated by institutions Conversations with exchange officials indicate that well over half the business is generated by broker/dealer firms for their own account. The wholesale nature of the market is corroborated by evidence that almost all the transactions in the most popular of the instruments—the options on bond futures—are for ten, twenty, or fifty contracts rather than for one or two The face value of the contracts is $100,000 Other users of options on debt instruments include savings and loan associations, commercial banks, and commodities houses.

Options on foreign currencies traded on the Philadelphia Stock Exchange appear to have generated substantial interest abroad, with more than half the business coming from Europe. Broker/dealers in the United States and abroad account for an estimated 30 percent of the business Corporate treasurers are believed to be the largest customer group. Several banks and some professional money managers are also using the market. The contracts have also attracted some retail interest.

Options versus futures as a hedging tool

There are established futures markets in the same instruments as the new options markets.[2] However,

[2] An option gives its purchaser the right to buy (or sell) an asset at a specific price up to a specific time but, unlike a futures or forward contract, does not *obligate* the buyer to acquire (or provide) the underlying security Consequently, the risk distribution for an option is quite different from that for a futures contract Whatever the price of the underlying security, an option buyer will never lose more than the premium paid The option seller can never gain beyond the premium charged At best, the seller will lose nothing and retain the entire premium With a futures or forward contract, the buyer may gain or lose, depending on the market price at maturity The lower (higher) the price of the contract at maturity relative to the original price, the more the buyer will lose (gain) and the seller will gain (lose)

since options and futures have different profit profiles, options contracts can be better hedges than futures contracts for some important kinds of risk exposure Options are ideally suited to hedge the risks of a potential transaction that is not certain to take place. Consider, for example, a U S firm that must submit a competitive bid in a foreign currency to provide a product but is unsure that its bid will be accepted. Here the normal business risks of competitive bidding are compounded by exchange risks. The rate of exchange is a substantial cost element in the bid price of the contract, but the firm will be reluctant to lock in these costs at the time it submits its bid—by selling its potential foreign currency receipts forward, for example—because it is uncertain about the outcome of the bidding process. However, the firm can create a perfect hedge against the contingent receivable by buying a put option in the foreign currency. If the firm's bid wins, the foreign currency can be "put" to the option seller. If the bid fails, the firm will simply not exercise the option

In a similar vein, a bank can use options to hedge its fixed-rate loan commitments to businesses These lines are attractive to the borrowers. If interest rates go up, the borrower will generally utilize the commitment; if rates fall, the borrower will let the commitment lapse. The bank has essentially written a put option. Banks may desire to provide this service to keep valuable customers, but they may not be so anxious to bear the full interest rate risk on their contingent liability. The bank can hedge this contingent liability by purchasing a put option on interest rates for an appropriate maturity, say, a Treasury note contract

There are situations in which options and futures can serve similar hedging purposes. Consider a bank with a longer repricing period on its assets than on its liabilities. This institution should gain from falling interest rates and lose from rising rates If the bank management believes that interest rates will rise more than accounted for by the term structure of interest rates, it can hedge via either futures or options. Both instruments would be attractive, since the option premium and the futures prices will look cheap in terms of the protection they provide to the bank. The choice between the two will depend on the cost of the option premium, how certain management is of their prediction of future interest rates, and the risk-return trade-off preferred by management The use of options for such a transaction is examined in Appendix 1.

Market mechanics, margins and delivery provisions

Margin requirements are a necessary protection for the clearinghouse members. On options contracts, the buyer pays the entire premium up front and is not subject to margin calls.[3] The seller of an uncovered option is subject to an initial margin requirement. If the market moves against him, he is also subject to additional or variation margin. A specific example of margin requirements on options and their calculation is given in Appendix 2

For options on futures contracts it is customary to hold interest-bearing assets in margin accounts. Consequently, initial margin requirements do not usually represent foregone interest for these contracts. For options on physicals, initial margin requirements must be posted in cash Alternatively, a security position can be held in lieu of the margin. For example, for an options contract on Treasury bills, Treasury bills with a par value equal to the par value on the contract can be posted instead of the margin. This is customarily done for options on debt securities. Variation margin must, in all cases, be posted in cash.

The terms of delivery for the new options contracts include cash settlement and physical delivery Options on futures contracts require delivery of the underlying futures contracts. Options on stock indexes require cash settlement—that is, the securities which comprise the Standard & Poor's (S&P) 100, for example, do not actually have to be delivered. Rather, the difference between the exercise price and the current price must be settled in cash. Foreign currency options require delivery of a specified amount of foreign currency

But options on debt instruments present a unique deliverability problem that arises because of the limited life of the underlying security. Other options (equities, stock indexes, foreign exchange) are written on physicals that have an infinite life and thus are not directly affected in their characteristics by the passage of time. But debt instruments get closer to maturity as the option gets closer to expiration. This feature of debt instruments requires that options on them take one of two forms: fixed deliverable or variable deliverable.

Fixed deliverable options require that a debt instrument with specified characteristics be delivered when the option is exercised For example, a three-month call option on a six-month Treasury bill would require that a Treasury bill with six months remaining to maturity be delivered. Contracts for fixed delivery allow for the possibility that the optioned security could have a shorter lifetime than the option itself. That is, a nine-month option on a three-month Treasury bill is possible, when the option is exercised, a three-month bill is

[3] It is interesting to note that, on futures contracts, both the buyer and seller are required to put up original margin requirements This can be posted in interest-bearing form If the market moves against them, either buyer or seller may be required to deposit variation margin to meet margin calls These calls must be met in cash, as the other party can draw them out in cash

delivered Treasury bills on the Amex are traded on a fixed deliverable basis.

A variable deliverable option specifies the existing debt issue that is deliverable against exercise This has been adopted for Treasury notes and bonds. For example, a one-year option on a ten-year bond spells out the specific ten-year bond to be delivered At the expiration of the option, the bond will have nine years to maturity. Thus the maturity date of the bond must be later than the option expiration date for variable deliverable options.[4]

Market development

Why the sudden emergence of these new markets? Increased use of futures contracts and existing equity options indicated to the management of the stock and commodities exchanges that the public desired new instruments which could serve a risk transfer function Proposals on some of these new options contracts were submitted as early as 1980. However, questions about the division of regulatory authority between the Commodity Futures Trading Commission (CFTC) and the Securities and Exchange Commission delayed the approval process, allowing other exchanges time to design similar, slightly differentiated products. The ultimate agreement, signed into law by President Reagan in October 1982, gave the SEC jurisdiction over options contracts on physical securities traded on organized securities and commodities exchanges, and options on foreign currency when traded on a national securities exchange. The CFTC has jurisdiction over options on financial futures.

The exchanges are well aware that the first to begin trading a product has a real advantage Liquidity will tend to develop in that market. If a second exchange enters with a similar product, even if it is slightly superior in design, it must compete with a market which has already developed liquidity Trades can be executed with greater ease in the first market, and hence gravitate there. It is extremely difficult for the second market to develop liquidity, and it generally fails Consequently, the competitive pressure between the exchanges induces the submission of numerous proposals on similar instruments.

Yet, if there were a demand for these products, why did over-the-counter markets not develop? Regulatory approval only is necessary for options to be traded on organized exchanges. The answer is in part that the use of an organized exchange avoids the potential for abuse that is inherent in an options contract Otherwise, the option buyer, who pays the premium up front, has very limited recourse if the writer does not uphold his obligations at the end of the contract

Trading of standardized contracts on an organized exchange overcomes this problem because it allows for the development of a clearinghouse On securities exchanges the clearinghouse assumes any credit risk Thus, the option really consists of two contracts: one between the buyer and the clearinghouse and the other between the seller and the clearinghouse. On commodities exchanges, the clearinghouse member which handles the writer's account assumes the credit risk. Consequently, a buyer of an exchange-traded option does not have to pass judgment on the creditworthiness of the seller[5]

While the clearinghouse or a clearing member thus assumes the credit risk in the contract, they can protect themselves against the risk by marking the contracts to market on a daily basis and assessing additional margin requirements as required by price movements If the margin calls are not met, the clearinghouse can move quickly to liquidate the contracts Two other reasons for the importance of an organized exchange is contract standardization, which allows for the development of liquidity, and a reported price, which gives option buyers and writers information on the price of the last actual trade This information can be used to evaluate returns better on the anticipated option strategy. Since trading on an organized exchange is preferable to trading on an over-the-counter basis, regulatory approval was a crucial ingredient for market creation.

Will all these new options markets survive?

There are four possible markets for any instrument a cash market, a futures market, an option on the cash market, and an option on the futures market. But, generally, the existence of all four markets on one instrument is redundant. A cash market, a futures market, and one options market will usually be sufficient to fulfill all risk-transfer possibilities, since the option on the cash market and the option on the futures market serve very similar functions.[6]

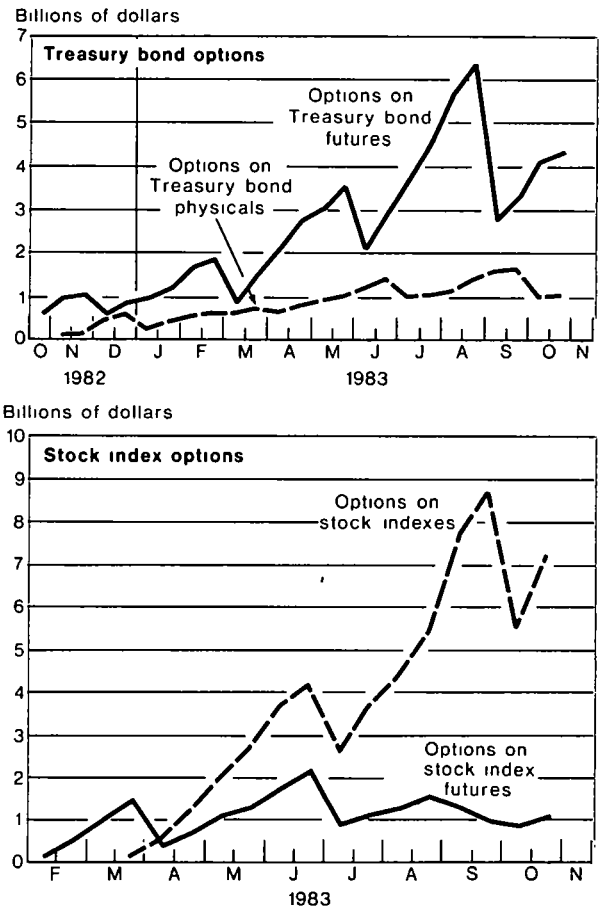
[4] The difference between fixed deliverable options and variable deliverable options is discussed more fully in Walter L Eckardt, Jr, "An Analysis of Treasury Bond and Treasury Bill Options Premiums", a paper presented at the second annual options colloquium sponsored by the Amex (New York, N Y, March 25-26, 1982)

[5] See Kenneth D Garbade and Monica M Kaicher, "Exchange-Traded Options on Common Stock", this *Quarterly Review* (Winter 1978-79), pages 26-40

[6] This point can be made by considering the limit case an option on a futures contract which expires the day the futures contract is delivered The delivery on the option would be settled at once, providing the actual security Here no distinction exists between an option on the futures contract and an option on the physical In reality, the options contract expires before the delivery date of the futures contract For example, for a December option on a bond future, the option would expire in November, resulting in delivery of a December futures contract It is unlikely that this small difference is enough to sustain two independent markets

The Options Contract Race

Total open interest



Sources Wall Street Journal, various dates, and information provided by the exchanges

If there is room for only one options market, what determines whether the option on the cash instrument or the option on the future wins out? Since there were only small differences in the start-up times of the various markets, technical or operational differences will make one market more desirable than the other For example, if the cash market is more liquid than the futures market, or has lower transactions costs, an option on the cash market would be preferred In the case of a commodity like gold, an option on the physical would involve the costs of assaying and delivery Consequently, for gold the options market has developed on the futures contract In the case of foreign exchange, spot markets are much deeper than the forward exchange markets [7] The futures market is smaller still In this case options are written on the spot currency contract

Options on both cash instruments and futures do currently coexist in markets where the reasons to prefer one type of option over the other are not so clear-cut But signs are already emerging to show which options will dominate Options on Treasury bond futures appear to be generating more business than options on Treasury bond physicals By contrast, the options market for stock indexes is more active than the market in options on stock index futures (chart)

Many market participants believe that the contract design of options on Treasury bond futures is slightly superior for three reasons For one, options on futures have no coupon or dividend payments By contrast, with an options contract on a bond or note, the buyer of a call or seller of a put must compensate the other party for accrued interest when exercise occurs Furthermore, options on bond futures are also believed to be "cleaner" instruments because of the reduced possibility of delivery squeezes Options on bonds are written on particular issues Since the supply of any particular issue is fixed after the date of issuance, there is always the chance of a squeeze developing that could artificially raise the price of that bond Options on bond futures, however, are written on the underlying futures contract, which, in turn, is written not on a particular bond issue but rather on a bond with particular characteristics One bond (usually a high coupon bond) will always be cheapest to deliver against the futures contract But, if there were a squeeze on this bond, other deliverable bonds would be available [8] Consequently, the deliverable supply of Treasury bond futures will always prove more than adequate Third, it is easier to learn the price of an underlying bond future rather than the bond itself For option pricing purposes it is crucial to know the price of the underlying security The price of the last bond futures trade is easily accessible, as bond futures and options on bond futures are traded on the same floor This saves the investor the trouble of canvassing dealers to obtain a price on the security itself

Options on stock indexes appear to be more popular

[7] A Federal Reserve Bank of New York turnover study showed that for April 1983 foreign exchange turnover in the United States was $702 5 billion Of this, $451 0 billion (or roughly two thirds) was in spot transactions, $42 0 billion was in outright forwards, and $209 4 billion was in swaps Foreign exchange futures turnover on the International Monetary Market is less than 10 percent of total foreign exchange turnover

[8] Conceptually, options on bonds could be written on a bond with particular characteristics rather than on a particular bond However, this would make certain option strategies, such as covered call writing, more difficult as the option would 'play to a single debt issue" and the issue may change over the life of the option

than options on stock index futures Of the four markets on stock indexes, the two most successful are the S&P 100 followed by the Amex Major Market. These two markets have attracted substantial retail interest as the contract sizes on these options are much smaller than those for options on the S&P 500, the Amex Market Value, or the stock index futures Moreover, options on stock index futures can be sold only by a CFTC registered representative Options on stock indexes can be sold by any registered representative. Thus, a stockbroker who services retail portfolios can market the S&P 100 and the Amex Major Market Index but not the options on the futures contracts [9]

While options on the Treasury bond futures and options on the S&P 100 appear to be doing somewhat better than their competitors, the contract race is not yet over. The markets are all relatively new, and the emergence of one contract over another takes time. But weaker markets face the threat of gradually losing liquidity through a loss of customers Participants who remain in those markets will find over time that their trades cannot be executed promptly enough or that bid-ask spreads are too wide.

Financial characteristics of the new options

The new options, particularly on debt instruments, have financial characteristics that are quite different from those of the more familiar equity options. An equity is the instrument with the same characteristics over the life of the option. Unlike equities, debt instruments have finite lives and their effective maturity shortens as time passes. This creates the distinction between fixed deliverable options and variable deliverable options as discussed above Both fixed deliverable and variable deliverable instruments attempt to capture some of the characteristics of options on equities. A fixed deliverable option tries to preserve the characteristics of a debt instrument (*i.e.*, its sensitivity to changes in interest rates) but must move from security to security to avoid the aging problem. The variable deliverable bond option stays with a single issue, but the characteristics of the issue age over time as the bond moves to maturity.

The other major difference between the new options and traditional equity options concerns the effects of financial variables—such as the level of interest rates—on the price of the options contract The standard theory of options pricing holds that changes in certain financial variables, including the level of interest rates, will have definite effects on the price of an equity option. For the new options, however, in some cases the effects of such factors may be ambiguous or even may go in the opposite direction to that predicted by traditional options pricing theory.

Valuation of new options instruments

In 1973 Black and Scholes described a formula for calculating the value of a call option on a stock.[10] This model, which has received wide recognition and attention, shows that the price of a call option depends on five factors· the price of the underlying security (S), the strike or exercise price of the option (E), the volatility of the price of the underlying security (s), the time remaining to maturity (T), and the level of interest rates (r) [11] It is useful to explore the extent to which the same factors are important in the pricing of the new options markets.[12] (The results of this section are summarized in Table 2, and the relationship between put and call prices is discussed in Appendix 3.)

The effect of changes in the underlying security price or the exercise price are unambiguous. For all call options, as the price of the underlying security increases or the exercise price decreases, the price of the option must increase because the intrinsic value is higher. The effect of increased volatility is similar for conventional equity options and new options instruments as described below. However, the analysis of changes in the time to expiration and the level of interest rates is different for new options instruments than for conventional equity options

[9] It should be noted that options on bond futures can be sold only by a CFTC registered representative, while options on bond physicals can be sold by any registered representative However, since there is little retail interest in the options on debt securities, this does not aid the exchange trading the options on Treasury debt securities

[10] See Fischer Black and Myron Scholes, "The Pricing of Options and Corporate Liabilities", *Journal of Political Economy* (May/June 1973)

[11] The Black-Scholes option pricing formula can be written as follows

$$c = SN(d_1) - Ee^{-rT}N(d_2)$$

where $d_1 = (\ln(S/E) + (r + 1/2s^2)T)/s\sqrt{T}$

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

In this formula, c is the value of the option, ln is the natural logrithm, e is the exponential and s^2 is the instantaneous variance of the stock price N( ) is the normal distribution function

[12] The Black-Scholes formula assumes that the stock's continuously compounded return follows a normal distribution with a constant variance, its expiration price will thus be "lognormally" distributed While this may be a good approximation for stock indexes and currencies, it is not a good assumption for variable deliverable debt instruments As mentioned previously, default-free bonds (other than "consols"), unlike common stock, do not have a perpetual life As maturity approaches, a default-free bond will be valued closer to par, all other factors constant Thus, even if interest rates remain unchanged, the passage of time alone will cause the price of a default-free bond to change Consequently, it cannot be assumed that prices of debt instruments follow a random walk Moreover, the variance of a bond will decline over time A longer bond will move more in response to a 100 basis point change in interest rates than a shorter bond

Table 2

Effects of Changes in Financial Factors on Pricing of New Options Instruments

Call options on instruments	Security price (S)	Exercise price (E)	Volatility of security price (s)	Time to expiration (T)	Factor Level of interest rates (r)
Conventional equity or stock index	+	−	+	+	+
Foreign currency	+	−	+	+	?
Fixed deliverable debt instrument	+	−	+	?	−
Variable deliverable debt instrument	+	−	+	+	−
Futures contract	+	−	+	?	−

This table should be read as follows. a plus sign indicates that an increase in the value of a factor will increase the value of a call option on an instrument; a minus sign indicates a decrease in the option value and a question mark indicates an ambiguous effect.

Volatility

For all options, the more volatile the underlying security price, the greater the value of the option. Consider the extreme case in which there are two securities, A and B. Security A is riskless and Security B is risky, but its mean return is the same as the sure value of Security A. Assume further that the exercise price of the option is the same as the value of Security A at expiration. Hence, an option on Security A will be worthless, as the exercise price is the same as its current value Security B has a probability one half of expiring worthless, and a probability of one half of expiring with value. Its current price will reflect this, and consequently will be positive. Consider now two risky securities with the same mean value. Security B is riskier than Security A. The argument easily generalizes, as Security B will have a greater probability of a higher value at expiration than Security A. It also has a greater probability of a lower value but, since the option cuts off the lower tail of the distribution, this does not matter. Thus, the value of options on more volatile securities, holding all other factors constant, will generally be greater.

Time to expiration

In the Black-Scholes model, an option with a longer time to expiration will be worth at least as much as another option with the same exercise price and a shorter time to expiration. The intuition is that an option with a longer time to expiration has all the attributes of an option with a shorter exercise date, as the longer option may be exercised before maturity. Once the shorter run option has expired, the longer term option can still be exercised. This is true for options on foreign currencies, options on stock indexes, and options on variable deliverable debt instruments as well.

This pricing property does not necessarily hold for options on futures and fixed deliverable options, although it will generally be the case. By way of illustration, consider the September and December call options on a futures contract. The time value of an option on a December future will, of course, be higher than that on a September future. But the September future is a different contract from the December future. Consequently, it is possible—if interest rates are currently very low and expected to rise sharply between September and December—for the option on the September future to have a positive intrinsic value, while the option on the December future has a zero intrinsic value. Thus, depending on the relative magnitudes of the time values and the intrinsic values, the option on the December future could conceivably be less valuable than the option on the September future.

Interest rates

The Black-Scholes formula shows that, as interest rates rise, the value of a call option must rise.[13] To understand this, note that holding a call option and holding the stock itself are alternative ways for an investor to capture any gain on the security price. Consequently, as rates rise, the cost of carry on the underlying security will rise and the call option will appear more attractive *vis-à-vis* the

[13] The model assumes that price movements are independent of the level of interest rates

underlying stock.[14] And what holds for an option on a single equity will hold for an option on a stock price index, which is just a basket of many individual equities

For options on stock index *futures*—and on futures contracts generally—there is no opportunity cost associated with holding a futures contract, as no funds need be expended until expiration Consequently, the interest rate effect will be negative although very small.[15] This can best be described by considering a riskless world The option buyer would be charged an amount equal to the present discounted value of the difference between the value of the futures contract at expiration and the exercise price (In a risky world, this difference would be higher by the amount of an implicit insurance premium.) Then, as interest rates go up, this present discounted value, which is the price of the call option, would decline. Essentially, the purchaser of the call is forfeiting interest until contract expiration on the original call price, for which cash must be put up front. However, since the futures price and the exercise price are expected to be relatively close when the option is originally purchased, interest rate variations are only a second-order effect in the price changes of these contracts.

Assuming that the price of the underlying security is independent of the level of interest rates is a reasonable simplification in the case of equity options However, it is an absurd assumption to make for options on debt instruments or on currencies. Major movements in the prices of debt instruments and exchange rates will occur *because* of changes in interest rates. For debt instruments, as interest rates rise, any cost of carry considerations will be dwarfed by the fall in the price of the underlying security[16]

Interest rate increases as a rule will have a negative impact on the price of options on bond futures, as a rise in interest rates will most likely cause a fall in the price of the underlying futures contract. And this loss is compounded by the negative effect of higher interest rates on the opportunity cost of the call premium.

The effect of interest rate changes on the value of a foreign currency option will generally be ambiguous For simplicity, consider the case where foreign interest rates are constant while dollar interest rates rise. The theory of interest rate parity holds that the forward premium or discount on foreign exchange should equal the differential between domestic and foreign interest rates. Then, as dollar interest rates rise, the forward exchange rate (expressed as dollars per unit of foreign currency) must rise relative to the spot rate The interest rate parity linkage allows the value of the options contract to be written equivalently in terms of either the spot or the forward exchange rate[17] And this equivalence in the valuation formulas for the option can be used to deduce the effect of interest rate changes on the option price. There are three cases.

- If the spot rate is unaffected by a rise in domestic interest rates, option values will rise, as in the case of a typical equity option, the cost-of-carry effect will dominate
- If the forward rate is unaffected by a rise in domestic interest rates, option values will fall. Intuitively, one can think of the option as being written on a futures contract that expires on the

[14] A more formal argument can be made as follows an investor buys 100 shares of stock worth $50 per share on margin But, instead of securing a typical margin loan, he makes an initial payment of size c, and promises $4,500 in six months The future payment is promised on a no-recourse basis with the stock used as collateral If the stock is worth less than $4,500 at expiration, the investor will allow the lender to claim the stock The investor has purchased a call option with an exercise price of $45 and a time to expiration of six months, c is the premium

If the loan were riskless, the lender would charge the investor an amount which would cover the difference between the value of the stock being delivered, S, and the present value of the future payment, Ee^{-rT} (in the example above, $4,500 is the future payment) If the loan were not riskless, the lender must charge enough to purchase an insurance premium to allow for the possibility that the stock price will be less than E dollars at expiration, leaving the lender with a loss of E − S Thus the price of the premium is the present value of the levered position in the stock plus the insurance premium, or $c = S - Ee^{-rT} + I$, where I is the insurance premium As interest rates rise, the present value of the future payment is less, hence the value of the levered position in the stock increases Thus, the value of the call option must increase

[15] Rational optional pricing of futures contracts takes the form

$$c = e^{-rT}[FN(d_1) - EN(d_2)]$$

where $d_1 = (\ln(F/E) + 1/2s^2T)/s\sqrt{T}$

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

F is the price of the futures contract This is the Black-Scholes option pricing formula given in footnote 11 if $F = Se^{rT}$

[16] See, for example, George Courtadon, "The Pricing of Options on Default Free Bonds", a paper presented at a Conference on Options Pricing Theory and Applications, sponsored by the Salomon Brothers Center for the Study of Financial Institutions (New York University, New York, N Y, January 18-19, 1982)

[17] See Mark B Garman and Steven W Kohlhagen, "Foreign Currency Option Values", unpublished working paper (School of Business Administration, University of California at Berkeley, December 1982), for a more technical discussion The authors have shown that the price of a call option on foreign exchange may be written as

$$c = e^{-r_f T}SN(d_1) - e^{-r_D T}EN(d_2)$$

where

$d_1 = (\ln(S/E) + (r_D - r_f + 1/2s^2)T)/s\sqrt{T}$

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

r_D = domestic interest rates, r_f = foreign interest rate

Alternatively,

$$c = e^{-r_D T}[FN(d_1) - EN(d_2)]$$

where

$d_1 = (\ln(F/E) + (1/2s^2T))/s\sqrt{T}$

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

same date as the option In this instance, the negative relationship existing between options on futures and interest rates will prevail

- If both the spot and forward rates change when domestic interest rates rise, the effect on option values cannot be determined without precise knowledge of how much either exchange rate moves.

Since the third case represents the typical adjustment, the effect of interest rate changes on foreign currency options values is indeterminate

To summarize, there are three interest rate effects at work There is a negative effect which relates to the cost of carry on the option premium—the call premium is paid when the contract is entered into and no proceeds are received until maturity or exercise. There is a positive effect which relates to the cost of carry on the underlying security. Finally, there is a negative effect of interest rates on the security price. The second effect dominates the first, and the third effect generally dominates the second For options on futures, only the first effect is present For options on conventional equities and equity indexes, the first two effects are present, and the impact of interest rates is positive For options on debt instruments, all three effects are present, and the third effect dominates. For foreign currencies, the extent to which the third effect is present depends on the relative movements of spot and forward exchange rates, thus the effect of interest rates is indeterminant

Options in the broader financial context

As risk in the financial environment has increased, many of the traditional risk bearers are no longer willing to play that role to so large an extent. Banking institutions have moved away from their conventional activity of borrowing short and lending long. Instead, they are confining the calculated interest rate risks they take to the short end of the maturity spectrum. Portfolio managers who feel they have a particular expertise in picking stocks now wish to remove the market component of their risk. Corporations are looking for ways to eliminate exchange rate risk that they had normally assumed in the course of their business. Consequently, changes have emerged in the financial system that enrich the menu of risk management techniques. The new options markets are one such example. These markets allow traditional risk bearers to lay off unwanted risks and provide alternative outlets for their customers.

It must be borne in mind that, while options provide real opportunities for market participants to lay off unwanted risk, and for sophisticated market participants to earn a return by accepting these risks, they also create the potential for unsophisticated writers of options to expose themselves to much larger risks than is prudent. The bank regulatory authorities are monitoring bank participation in these markets in an effort to assess what types of activities commercial banks should be able to engage in and what limits should be placed on these activities.

The interest in these markets from the Federal Reserve System's point of view goes well beyond regulatory rules for banks The existence of these markets may well alter the risk-taking behavior of financial intermediaries and real sector participants. If the markets become very important, they could affect the response of the economic system to real and monetary disturbances. However, it is still too early to tell even which option markets will succeed in establishing themselves and how large they will become Time and careful study will allow us to determine the full implications for the behavior of market participants

Laurie S. Goodman

Appendix 1: An Illustrative Trade

To appreciate fully the flexibility of option instruments, it is useful to work out an illustrative example Let us consider a depository institution—a bank, for instance—and examine how it could use options in asset-liability management Let us assume that the financial institutions believe that interest rates will rise more than is expected in the current term structure The bank has some long-term fixed rate commercial loans and mortgages and is funded by shorter term instruments. To hedge itself the bank wants to buy a put option on a bond future If interest rates rise, the bank's higher funding costs will be offset or nearly offset by the gain on the options contract

Meanwhile, a professional money manager across town has very different interest rate expectations He believes that interest rates will fall more than is expected in the current term structure. He would like to collect the fee income from writing a put option on a bond future * There is clearly room for a trade between the financial institution and the money manager

We assume that it is December, the market price of a March futures is 70-00, and the strike price on the option is 70. The premium is $2,000 for $100,000 face value of bonds The bank thinks there is a 75 percent probability the futures price in March will be 65 and there is a 25 percent probability the price will go up to 72 If the price goes above 70, the bank will not exercise the contract. Thus, the bank perceives this contract as having a positive expected value, as it has a 75 percent chance of making $5,000 and a 25 percent chance of making nothing Thus, the expected value of the contract is $3,750 and its cost is $2,000 †

Meanwhile the money manager believes that there is a 25 percent probability the futures price in March will be 65 and a 75 percent probability the futures price in March will be 72 The expected cost of this contract to the money manager is $1,250, and he will receive the $2,000 premium Thus, his expected profit is $750 Let us look at four scenarios at expiration (table).

Benefits (Losses) to Parties in Option Contract

Market outcomes	Bank (buyer)	Money manager (writer)
Futures price is 70 or above March/70 put expires worthless	−2,000 premium	+2,000 premium
Futures price is 69 March/70 put expires +1	−2,000 premium +1,000 option −1,000	+2,000 premium −1,000 option +1,000
Futures price is 68 March /70 put expires +2	−2,000 premium +2,000 option breakeven	+2,000 premium −2,000 option breakeven
Futures price is 65 March/70 put expires +5	−2,000 premium +5,000 option +3,000	+2,000 premium −5,000 option −3,000

Note that, while in scenario 1 the bank has lost the $2,000 option premium, interest rates have fallen or held steady Consequently, the bank will have a gain on its portfolio Therefore, while the bank would have been better off not buying the option, the hedge worked as it was supposed to That is, the hedge provided insurance against rising interest rates while preserving the value of the bank's portfolio should interest rates fall.

In the example described above, the money manager writing the put leaves himself with an unlimited exposure if interest rates rise (bond prices fall) If the money manager has interest rate expectations as described above but wants to limit his downside risk, he could write a put option at 70 and buy a put option at 65 If the bond futures contract price comes in below 65, the money manager could exercise the March/65 put. The initial cost of the March/65 put is low, as it is fairly far out of the money, say it costs $250. The money manager would then collect $1,750 in net premium income but would have limited his possible loss to $5,000 on the option. This strategy is called a "bull put spread" (meaning the investor is bullish on bond prices).

The money manager may also have written the put option as part of a straddle. In a straddle, the writer anticipates that interest rates and bond prices will be relatively flat Writing a straddle involves writing a put and a call option at the same exercise price for the same expiration. If the premium on a March/70 call option is $2,000, the money manager will have collected $4,000 in fee income. Thus, he will break even or make money if the bond futures contract price stays in the range of 66-74. If it moves outside that range, he will experience a net loss on the transaction ‡ Intuitively, if the call is in the money, the put will be out of the money. Since $4,000 in premium income has been collected, the money manager will lose money if the loss on either the put or the call is more than $4,000

*It should be noted that the money manager could also have taken advantage of his interest rate expectations by buying a call option

†It is plausible that a risk-averse bank would enter a contract which it believes had negative expected value because of its usefulness as a hedge

‡It is not necessary to write a put and call option at the same strike price The investor can modify the risk-return relationship by writing options with different strike prices In each case, the maximum potential profit is the total of the premiums received The downside break-even point is the put strike price less the total premium received The upside break-even point is the call strike price plus the total premium received

Appendix 2: Calculation of Margin Requirements

Margin requirements on options can best be illustrated by an example. Let us consider an investor who wishes to write a call option on thirteen-week Treasury bills on the American Stock Exchange (Amex). Margin requirements are governed by three rules *

(1) If the option is in the money, the writer must hold a margin equal to the premium plus a fixed amount In the case of calls on the Amex, the fixed amount is $3,500.

Example. A customer writes an uncovered thirteen-week T-bill call option with a strike price of 88. This means the bill is at a 12 percent discount (*i.e.*, the strike price for $1,000,000 face value of the bill is roughly $970,000) The market price of the bill is 90, that is, the bill is at a 10 percent discount ($975,000 for $1,000,000 face value). The option is selling at $6,250 for $1,000,000 face value of the bill Thus, the margin requirement is

Option premium	$6,250
Plus fixed amount	$3,500
Total	$9,750

(2) If the option is out of the money, the writer must hold a margin equal to the premium plus a fixed amount less the amount the option is out of the money.

(3) The minimum margin requirement is the option premium plus $500 per contract

Example. In the example above, the market price of the T-bill call option falls to 85. The option is selling for $1,500 Thus, the margin requirement is.

Option premium	$1,500
Plus fixed amount	$3,500
Total	$5,000
Minus out-of-the-money amount.	−$7,500
Total	−$2,500

However, the minimum margin requirement is the option premium +$500 per contract. In this example, we have:

$1,500 option premium + $500 or $2,000.

Thus, the maintenance margin requirement is $2,000.

*Additionally, the initial deposit in a new margin account must total at least $2,000

Appendix 3: Put-Call Parity

The text discussed the relationship between various financial factors and the call option price of new options instruments This appendix investigates the relationship between prices on put and call options

To gain some insight into the connection between put and call prices for equity options consider the following portfolio strategy. An investor buys a security for a price of S dollars He finances his purchase by borrowing Ee^{-rT} dollars, promising to repay E dollars at the expiration of the option At the same time, he buys a "European" put option for a premium of p dollars (A European option cannot be exercised before maturity, whereas an American option can) The initial value of this portfolio is $S+p-Ee^{-rT}$

At the expiration of the option, the security will be worth S_1. If S_1 is less than E, the investor will exercise the option and receive the exercise price of E with which the maturing loan will be repaid The value of the investor's portfolio at the expiration date then is zero If S_1 is greater than E, the investor will not exercise the put option but can sell the security in the market for S_1, repay the loan, and have S_1-E dollars left over The payoff structure of this portfolio may be summarized as follows

Scenario	Value of put option	Value of security	Repayment of loan	Total
$S_1 < E$	$E-S_1$	S_1	$-E$	0
$S_1 \geq E$	0	S_1	$-E$	S_1-E

This portfolio strategy has been selected so that its payoff structure exactly matches that from a European call option, (*i.e.*, max $(0,S_1-E)$) To avoid arbitrage opportunities, a call option must sell for a price equal to the initial price of this equivalent portfolio Thus, the traditional put-call parity equation

$$(1)\quad c = p + S - Ee^{-rT}$$

This equation holds for options on individual equities and options on stock indexes

For bond options, a minor adjustment is needed to take into account coupon payments Let G_0 be the accrued interest at the time of purchase of the option, and G_1 the accrued interest on the bond at the end of the life of the option If the call is exercised, the buyer will receive S_1-E The security's value will be S_1+G_1. If the put is exercised, the buyer will receive $E-S_1$. Consequently, the investor must borrow $(E+G_1)e^{-rT}$ rather than Ee^{-rT} Put-call parity can then be rewritten:

$$(2)\quad c = p + S + G_0 - (E+G_1)e^{-rT}.$$

For futures contracts, consider a portfolio which consists of writing a call, purchasing a put, and establishing a long futures position at price F As before, all instruments have the same expiration date and the options have the same exercise price At expiration, the payoff where F_1 is the futures price looks like·

Scenario	Sell a call	Buy a put	Buy a futures	Total
$F_1 < E$	0	$E-F_1$	F_1-F	$E-F$
$F_1 \geq E$	$E-F_1$	0	F_1-F	$E-F$

The initial value of this riskless position is the cost of the put less the income received from the call Discounting the portfolio earnings at maturity and setting them equal to the initial value gives

$$(3)\quad c = p + (F-E)e^{-r_D T}$$

The relationship between puts and calls on currency options can be derived from this If interest rate parity holds,

$$(4)\quad F = Se^{(r_D-r_f)T},$$

where r_D is the domestic interest rate and r_f is the foreign interest rate Arbitrage actions that establish interest rate parity can be conducted by borrowing the foreign currency, buying spot exchange, and investing the proceeds instead of purchasing a futures contract Thus, equation (4) may be substituted into equation (3) to obtain

$$(5)\quad c = p + Se^{-r_f T} - Ee^{-r_D T}$$

A fixed deliverable option is essentially an option on a futures contract that expires on the date the option expires Intuitively, a three-month call option on a six-month Treasury bill requires that a bill with six months to maturity be delivered at expiration Purchasing a three-month futures on a six-month bill also requires that a bill with six months to maturity be delivered Essentially, fixed deliverable options instruments are very similar to options on futures contracts The same relationship between put and call prices holds as in the case of options on futures