The pace of financial innovation has increased in recent years. Call option trading in sixteen individual common stocks was authorized only twelve years ago on the Chicago Board Options Exchange (CBOE). Today put options as well as call options on about 360 individual stocks are traded on five exchanges—the American Stock Exchange (AMEX), the Philadelphia Stock Exchange, the Pacific Coast Exchange, the Midwest Stock Exchange, as well as on the CBOE—and the volume of stock option trading measured by the value of underlying contracts rivals that of the New York Stock Exchange (NYSE). This period has also seen the introduction of futures contracts on financial instruments, such as government securities and other debt instruments, currencies, and stock indexes. The most recent innovation has been the creation of options on instruments other than individual common stocks: on bonds, on stock indexes, on currencies, and on commodities. These new options, introduced since 1982, are the focus of this chapter.

Because options are complex, we first provide background information. In the section "The New Option Instruments" we describe options and the new option instruments. In the following section we examine several elements in the operation of exchange option markets—the function of the clearinghouse, how profits or losses are realized, and how market making and floor trading differ between stock exchanges and futures exchanges—and briefly describe the regulation of the new options.

Policy makers have frequently expressed concern that options may not serve any economic purpose. This issue is examined from two perspectives in the section "Economic Purpose of Options." First, the uses of options as a risk management tool are examined from the perspective of private users of options. Second, the social costs and benefits of options are considered. Social costs may arise if options are merely a form of gambling, if they detract from the liquidity of underlying assets or from the capital formation process.
itself, or if they can be manipulated or are otherwise subject to trading abuses. We conclude that the social costs are few and that options confer social benefits by making possible more efficient sharing of risk in the economy. Insofar as option prices are linked to the price of the underlying asset, options trading can enhance the depth and liquidity of underlying asset markets by increasing investors’ interest in an underlying asset and its derivative securities.

In the section “Option Pricing” we present the pricing relations linking an underlying asset, an option on that asset, a futures contract on that asset, and an option on the futures contract. Empirical evidence on the pricing process indicates that these four instruments are closely linked and that factors affecting the price of one are transmitted to the others.

The rapid expansion in the number of new option instruments has raised concerns about undue proliferation of new option instruments. We examine factors affecting the introduction, success, and failure of new options. Many new options have been introduced; many have failed. The arguments against restricting the introduction of new options are presented.

The advent of derivative financial instruments makes it possible to accomplish a given investment objective by alternative means. A long position in an underlying asset, for example, can be replicated by using a futures contract or by using put and call options. The costs of these alternative positions will be affected by the margin required. Questions relating to the appropriate margining of the new options and to margin regulation are examined in the section “Margin Requirements.” The chapter ends with a section of summary and conclusions.

The New Option Instruments

In this section the general characteristics of an option on any underlying item and the payoffs to different option positions are considered. The new exchange-traded option instruments that are the focus of this study are described, and over-the-counter options are briefly examined.

What Are Options? An option conveys the right to buy or sell an underlying item at a specified price within a specified period of time. The right to buy is referred to as a call option; the right to sell is a put option. Options are generally described by the nature of the underlying item: an option on a common stock is said to be a stock option, an option on a futures contract is a futures option, and an
option on a commodity is a commodity option. The specified price at which the underlying item may be bought or sold is called the exercise price or the striking price. To buy or sell the underlying item in accordance with the option contract is to exercise the option. Options traded in the United States—called American options—can be exercised at any time up to and including the expiration date. If an option can be exercised only at expiration, it is termed a European option.

The buyer of an option pays the option writer (the seller) an amount of money called the option premium. In return the buyer receives the privilege of buying—but does not incur the obligation to buy—the underlying item for the exercise price at any time up to the expiration date. If the price of the item exceeds the exercise price, the call option is said to be in the money, and the call option buyer can exercise his option, thereby earning the difference between the two prices—the exercise value. If the price of the item is below the exercise price, the call option is out of the money and will not be exercised.

An example of futures options on the Standard and Poor's (S&P) 500 stock index will help to clarify options (see table 4–1). The contract size is $500 times the index value. A buyer of a September call at a striking price of 155 paid a premium of $1,600 ($3.20 × $500) for the right to buy one contract of September S&P 500 stock index futures at $77,500 ($155.00 × $500) at any time before the expiration date, the third Friday in September. If the price of the September index futures, at 154.90 on July 10, increased in value, say to 160, the call buyer could exercise the call, take delivery of the futures

<table>
<thead>
<tr>
<th>Striking Price</th>
<th>Calls</th>
<th></th>
<th>Puts</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>September</td>
<td>December</td>
<td>September</td>
<td>December</td>
</tr>
<tr>
<td>150</td>
<td>6.25</td>
<td>n.a.</td>
<td>1.40</td>
<td>2.20</td>
</tr>
<tr>
<td>155</td>
<td>3.20</td>
<td>6.35</td>
<td>3.30</td>
<td>3.90</td>
</tr>
<tr>
<td>160</td>
<td>1.40</td>
<td>4.00</td>
<td>6.45</td>
<td>6.25</td>
</tr>
<tr>
<td>165</td>
<td>0.50</td>
<td>2.30</td>
<td>10.45</td>
<td>9.45</td>
</tr>
</tbody>
</table>

Note: n.a. = not available. S&P 500 index values: spot, 152.89; September futures, 154.90; December futures, 157.65.
contract, and sell the futures contract to earn a profit of $900 \([160.00 - 155.00 - 3.20] \times 500\). Alternatively, since the option value reflects its exercise value, the option itself could be sold for the same profit. Note that on July 10 the option with a striking price of 155 was slightly out of the money since the index was at 154.90. The call buyer paid a premium for the option on the expectation that sometime before September the index would reach at least 158.20 \((155 + 3.20)\).

The buyer of a September put option paid 3.30 for the option to sell at 155. This option was slightly in the money on July 10 and thus carried a slightly larger premium than the call option. The put option would become profitable if the September index futures fell below 151.70 \((155 - 3.3)\) before the third Friday in September. The factors explaining the option premiums for different striking prices and different maturities are described later in this chapter.

It is important to note that the call option writer faces payoffs exactly opposite those of the buyer. If the call is in the money at expiration, the option writer must deliver an item worth more than the exercise price received. In the preceding example, the option writer in effect purchases the index futures at 160 and delivers it to the option buyer at 155. The loss is offset in part by the premium of 3.30, and the total loss equals the option buyer's total profit. If the call is out of the money at expiration, the option is not exercised, and the option writer keeps the premium he collected from the buyer when the option contract was written.

The buyer and the seller of a put option contract have the same zero-sum payoffs when the option is exercised. If the item price is below the exercise price, the buyer will exercise the option and realize a net profit equal to the writer's loss. If the item price is above the exercise price, the put option is out of the money and expires worthless.

**Option Positions—Profit Diagrams.** In this section, the relation between the put and call option payoffs and the price of the underlying item is demonstrated graphically. The underlying item is assumed to be a futures contract, although the analysis is general in the sense that the underlying item may be any financial instrument or commodity. The options are assumed to be held to maturity, \(T\).

To begin, it is useful to establish the profit diagrams for a futures position. An individual who enters into a long futures contract when the futures price is \(F\) agrees to pay \(F\) for the underlying item when the position is closed at time \(T\). At time \(T\) the futures price, \(F_T\), minus the purchase price, \(F\), represents the profit from the long futures
The maximum loss from this position is $F$ since the lowest value the futures may obtain is 0, and the maximum gain from the position is unlimited. The strategy has a zero profit when the terminal futures price equals the initial value (that is, $F_T = F$). Panel A of figure 4-1 depicts the profit diagram for a long futures position.

The profit picture for a short futures position is exactly opposite that of the long futures position because of the zero-sum nature of futures contracts. Panel B represents the short futures profit diagram. The maximum loss is unlimited, the maximum gain is $F$, and the break-even point is where the terminal futures price equals the initial value.

The call option profit diagrams are depicted in figure 4-2. A long call position entails a maximum loss of the option premium, $C$, an unlimited maximum gain, and a break-even point where the terminal futures price is equal to the exercise price of the option plus the option premium. A short call position has an unlimited loss, a maximum gain of $C$, and the same break-even futures price, again reflecting the zero-sum nature of such instruments.

Figure 4-3 shows the profit diagrams for long and short positions in the put option. The maximum loss of a long put position is the premium, the maximum gain is the exercise price less the premium, and the break-even terminal futures price is the exercise price less the premium. The short put position has exactly opposite payoffs.

Occasionally a long futures position is thought to be the same as a long call position. A comparison of figures 4-1 and 4-2 shows that this is clearly not the case. Although a call has the potential profits of a futures contract, it avoids the losses from a futures price decline. Thus a long futures position and a long call position are quite different.

Buying a call and writing a put, however, provide a long futures position. This is illustrated in figure 4-4 for the case in which the futures price equals the option’s exercise price. The maximum loss from the strategy is $F$, which is the maximum loss from writing a put; the maximum gain from buying the call is unlimited; and the break-even terminal futures price is $F$. These are exactly the contingencies posed by the long futures position. The long call–short put option strategy is sometimes referred to as a synthetic long futures position. Conversely, a portfolio consisting of a short position in the call and a long position in the put provides a synthetic short position in the futures, as shown in panel B.

Certain combinations of futures and futures options provide synthetic options positions. For example, a portfolio consisting of a long position in futures and a short position in the call option on
FIGURE 4–1
PROFIT DIAGRAMS FOR NAKED FUTURES POSITIONS

A. Long Futures

Profit

Futures price, \( F_T \)

Initial futures price, \( F \)

\(-F\)

Maximum gain = \(+\infty\)
Maximum loss = \(-F\)

B. Short Futures

Profit

F

Initial futures price, \( F \)

Futures price, \( F_T \)

Maximum gain = \( F \)
Maximum loss = \(-\infty\)
FIGURE 4–2
PROFIT DIAGRAMS FOR NAKED CALL OPTION POSITIONS

A. Long Call

Profit
0

Exercise price, X

Futures price, \( F_T \)

Break-even futures price, \( X + C \)

Maximum gain = +\( \infty \)

Maximum loss = \(-C\)

B. Short Call

Profit
C

Exercise price, X

Break-even futures price, \( X + C \)

Futures price, \( F_T \)

Maximum gain = \( C \)

Maximum loss = \(-\infty\)
FIGURE 4–3
PROFIT DIAGRAMS FOR NAKED PUT OPTION POSITIONS

A. Long Put

Profit

$X - P$

Break-even
futures
price, $X - P$

Exercise
price, $X$

Futures
price, $F_T$

$0$

$-P$

Maximum gain = $X - P$
Maximum loss = $-P$

B. Short Put

Profit

$P$

Break-even
futures
price, $X - P$

Exercise
price, $X$

Futures
price, $F_T$

$0$

$X + P$

Maximum gain = $P$
Maximum loss = $-X + P$
FIGURE 4-4
PROFIT DIAGRAMS FOR SYNTHETIC FUTURES POSITIONS

A. Synthetic Long Futures
(long call and short put)

- Maximum gain = $+\infty$
- Maximum loss = $-F$

B. Synthetic Short Futures
(short call and long put)

- Maximum gain = $F$
- Maximum loss = $-\infty$
the futures is equivalent to writing a put on the futures; that is, it is a synthetic short put position. The portfolio compositions yielding synthetic options positions are as follows:

<table>
<thead>
<tr>
<th>Portfolio Composition</th>
<th>Synthetic Option Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long futures</td>
<td>Long call</td>
</tr>
<tr>
<td>Long put</td>
<td></td>
</tr>
<tr>
<td>Short futures</td>
<td>Short call</td>
</tr>
<tr>
<td>Short put</td>
<td></td>
</tr>
<tr>
<td>Short futures</td>
<td>Long put</td>
</tr>
<tr>
<td>Long call</td>
<td></td>
</tr>
<tr>
<td>Long futures</td>
<td>Short put</td>
</tr>
<tr>
<td>Short call</td>
<td></td>
</tr>
</tbody>
</table>

The profit diagrams and their implications presented in this section are intended to be illustrative only. More formal relations between option prices and the prices of the underlying instruments are presented later. The profit diagrams will prove useful, however, in subsequent discussions about the payoff contingencies of option portfolios.

Types of New Exchange-traded Options. A complete list of the new options instruments is given in table 4–2. They are divided into options on physical assets and options on futures.

Options on physical assets. The first options on physicals—options on debt instruments—were introduced by the AMEX and the CBOE in October 1982. Since then options written directly on stock indexes and on currencies have also been introduced.

Options on stock indexes are offered on five exchanges: the CBOE, the AMEX, the NYSE, the Philadelphia Stock Exchange, and the Pacific Coast Exchange. Six options are on broad-based indexes, and eleven are on narrow-based industrial indexes. Unlike options on common stocks, these options are settled in cash. If, for example, a call option finishes in the money, the option holder receives in cash the difference between the index and the exercise price. Options on the broad-based indexes enjoy greater trading volume than those on the narrow-based indexes, and, within the broad-based index group, the CBOE's options on the S&P 100 index have the greatest interest.

Options on debt instruments are offered on the CBOE and the AMEX. None of these options, written on U.S. government Treasury
obligations, has generated much interest. The T-bond and T-note option contracts require delivery of the underlying Treasury instrument if the option is exercised; the T-bill requires the delivery of a bill that has ninety days to expiration.

The Philadelphia Stock Exchange lists options on six currencies: the British pound, the Canadian dollar, the West German mark, the Japanese yen, the Swiss franc, and the French franc. If the option is exercised, the underlying currency must be delivered.

Options on futures contracts. A number of the options, as shown in table 4–2, are options on futures contracts. If a futures option is exercised, the underlying futures contract is delivered. The options may be categorized according to the nature of the item underlying the futures contract. Currently, futures options are written on stock indexes, debt instruments, currencies, and several commodities.

Under a pilot program instituted in December 1981, the Commodity Futures Trading Commission (CFTC) approved options for a limited number of futures contracts on commodities other than domestic agricultural commodities. The first of these futures options (on T-bonds, sugar, and gold) did not begin trading until October 1982. The ban on options trading in domestic agricultural commodities established in the Commodity Exchange Act of 1936 was lifted by the Futures Trading Act of 1982, and now a second option pilot program (approved in March 1984) allows for domestic agricultural options as well. Each pilot program runs for three years and is intended to allow close monitoring by the CFTC of the development of these markets and compliance with the various rules established by the CFTC. Under the first pilot program each futures exchange is allowed to propose two options. Options on stock index futures (S&P 500, NYSE composite, Value Line index), T-bond futures, German mark futures, gold futures, and sugar futures were approved under the pilot program. Under the second pilot each futures exchange is allowed to propose two agricultural options. Futures options on corn, soybeans, live hogs, live cattle, wheat, and cotton were approved under this program.

Only two of the futures options on stock indexes are currently active—options on the S&P 500 on the Chicago Mercantile Exchange (CME) and options on the NYSE composite index on the New York Futures Exchange (NYFE). Both options expire at the same time as the underlying futures contract. For the S&P 500 futures options it is the third Friday of the contract month; for futures options on the NYSE composite, it is the next to last business day of the month.

Futures options are currently traded on a long-term debt instru-
<table>
<thead>
<tr>
<th>Underlying Item (Exchange)</th>
<th>Contract Size</th>
<th>Expiration Months</th>
<th>Cycle</th>
<th>Number</th>
<th>Start of Trading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Options on physical assets</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Broad stock indexes (contract size in dollars)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S&amp;P 100 (CBOE)</td>
<td>100 I</td>
<td>Monthly</td>
<td>4</td>
<td>Mar. 11, 1983</td>
<td></td>
</tr>
<tr>
<td>Major market (AMEX)</td>
<td>100 I</td>
<td>Monthly</td>
<td>3</td>
<td>Apr. 29, 1983</td>
<td></td>
</tr>
<tr>
<td>S&amp;P 500 (CBOE)</td>
<td>100 I</td>
<td>Quarterly</td>
<td>3</td>
<td>July 1, 1983</td>
<td></td>
</tr>
<tr>
<td>Market value (AMEX)</td>
<td>100 I</td>
<td>Monthly</td>
<td>3</td>
<td>Sept. 23, 1983</td>
<td></td>
</tr>
<tr>
<td>NYSE composite (NYSE)</td>
<td>100 I</td>
<td>M/Q</td>
<td>5</td>
<td>Sept. 23, 1983</td>
<td></td>
</tr>
<tr>
<td>Value line index (Philadelphia)</td>
<td></td>
<td>Monthly</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Narrow stock indexes (contract size in dollars)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computer technology (AMEX)</td>
<td>100 I</td>
<td>Monthly</td>
<td>3</td>
<td>Aug. 26, 1983</td>
<td></td>
</tr>
<tr>
<td>Oil and gas (AMEX)</td>
<td>100 I</td>
<td>Monthly</td>
<td>3</td>
<td>Sept. 9, 1983</td>
<td></td>
</tr>
<tr>
<td>S&amp;P international oils (CBOE)</td>
<td>100 I</td>
<td>Quarterly</td>
<td>3</td>
<td>Sept. 19, 1983</td>
<td></td>
</tr>
<tr>
<td>Computer and business equipment (CBOE)</td>
<td>100 I</td>
<td>Quarterly</td>
<td>3</td>
<td>Sept. 28, 1983</td>
<td></td>
</tr>
<tr>
<td>Gold/silver (Philadelphia)</td>
<td>100 I</td>
<td>M/Q</td>
<td>5</td>
<td>Dec. 19, 1983</td>
<td></td>
</tr>
<tr>
<td>Gaming/hotel (Philadelphia)</td>
<td>100 I</td>
<td>M/Q</td>
<td>5</td>
<td>Dec. 19, 1983</td>
<td></td>
</tr>
<tr>
<td>Technology (Pacific)</td>
<td>100 I</td>
<td>Monthly</td>
<td>3</td>
<td>Jan. 1984</td>
<td></td>
</tr>
<tr>
<td>Telephone (CBOE)</td>
<td>100 I</td>
<td>Quarterly</td>
<td>3</td>
<td>Mar. 20, 1984</td>
<td></td>
</tr>
<tr>
<td>Transportation (CBOE)</td>
<td>100 I</td>
<td>Monthly</td>
<td>3</td>
<td>Mar. 20, 1984</td>
<td></td>
</tr>
<tr>
<td>Transportation (AMEX)</td>
<td>100 I</td>
<td>Monthly</td>
<td>3</td>
<td>Mar. 20, 1984</td>
<td></td>
</tr>
<tr>
<td>Telephone (NYSE)</td>
<td>100 I</td>
<td>M/Q</td>
<td>5</td>
<td>Mar. 20, 1984</td>
<td></td>
</tr>
<tr>
<td>Debt instruments (contract size in dollars)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U.S. T-bonds (various issues) (CBOE)</td>
<td>100,000</td>
<td>Quarterly</td>
<td>3</td>
<td>Oct. 22, 1982</td>
<td></td>
</tr>
<tr>
<td>U.S. T-notes (various issues) (AMEX)</td>
<td>100,000</td>
<td>Quarterly</td>
<td>3</td>
<td>Oct. 22, 1982</td>
<td></td>
</tr>
<tr>
<td>U.S. T-bills (AMEX)</td>
<td>1,000,000</td>
<td>Quarterly</td>
<td>3</td>
<td>Oct. 22, 1982</td>
<td></td>
</tr>
<tr>
<td>Foreign currencies (Philadelphia) (contract size in foreign currency)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>British pound</td>
<td>12,500</td>
<td>Quarterly</td>
<td>3</td>
<td>Dec. 10, 1982</td>
<td></td>
</tr>
<tr>
<td>Canadian dollar</td>
<td>50,000</td>
<td>Quarterly</td>
<td>3</td>
<td>Feb. 28, 1983</td>
<td></td>
</tr>
<tr>
<td>West German mark</td>
<td>62,500</td>
<td>Quarterly</td>
<td>3</td>
<td>Feb. 28, 1983</td>
<td></td>
</tr>
<tr>
<td>Japanese yen</td>
<td>6,250,000</td>
<td>Quarterly</td>
<td>3</td>
<td>Feb. 28, 1983</td>
<td></td>
</tr>
<tr>
<td>Swiss franc</td>
<td>62,500</td>
<td>Quarterly</td>
<td>3</td>
<td>Feb. 28, 1983</td>
<td></td>
</tr>
<tr>
<td>Option Type</td>
<td>Futures Size</td>
<td>Contract Expiration</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>--------------</td>
<td>---------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>French franc</td>
<td>125,000</td>
<td>Quarterly 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Options on futures</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Broad stock index futures (contract size in dollars)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S&amp;P 500 index (CME)</td>
<td>500 I</td>
<td>Quarterly 3</td>
<td>Jan. 28, 1983</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NYSE composite index (NYFE)</td>
<td>500 I</td>
<td>Quarterly 3</td>
<td>Jan. 28, 1983</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Value Line index (KCBT)</td>
<td>500 I</td>
<td>Quarterly</td>
<td>Mar. 4, 1983</td>
<td></td>
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<td>Debt instrument futures (contract size in dollars)</td>
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<td></td>
</tr>
<tr>
<td>U.S. T-bonds (CBT)</td>
<td>100,000</td>
<td>Quarterly 3</td>
<td>Oct. 1, 1982</td>
<td></td>
<td></td>
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<td>Eurodollar (CME)</td>
<td>1,000,000</td>
<td>Quarterly</td>
<td></td>
<td></td>
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<td>Currency futures (CME) (contract size in foreign currency)</td>
<td>125,000</td>
<td>Quarterly 2</td>
<td>Jan. 24, 1984</td>
<td></td>
<td></td>
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<tr>
<td>West German mark</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>British pound</td>
<td>25,000</td>
<td>Quarterly 2</td>
<td>Feb. 25, 1985</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Swiss franc</td>
<td>125,000</td>
<td>Quarterly 3</td>
<td>Feb. 25, 1985</td>
<td></td>
<td></td>
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<tr>
<td>Commodity futures</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sugar #11 (CSCE)</td>
<td>112,000 lb.</td>
<td>Irregular</td>
<td>Oct. 1, 1982</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gold (COMEX)</td>
<td>100 troy oz.</td>
<td>Irregular</td>
<td>Oct. 4, 1982</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Live hogs (CME)</td>
<td>30,000 lb.</td>
<td>Irregular</td>
<td>Feb. 1, 1985</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Live cattle (CME)</td>
<td>40,000 lb.</td>
<td>Irregular</td>
<td>Oct. 30, 1984</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn (CBT)</td>
<td>5,000 bu.</td>
<td>Irregular</td>
<td>Feb. 27, 1985</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soybeans (CBT, MACE)</td>
<td>5,000 bu.</td>
<td>Irregular</td>
<td>Oct. 30, 1984</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cotton (NYCE)</td>
<td>50,000 lb.</td>
<td>Irregular</td>
<td>Oct. 30, 1984</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat (MACE, MGE, KCBT)</td>
<td>5,000 bu.</td>
<td>Irregular</td>
<td>Oct. 4, 1984</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silver (COMEX)</td>
<td>5,000 troy oz.</td>
<td>Irregular</td>
<td>Oct. 4, 1984</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silver (CBT)</td>
<td>1,000 troy oz.</td>
<td>Irregular</td>
<td>Oct. 4, 1984</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: CBOE = Chicago Board Options Exchange; AMEX = American Stock Exchange; NYSE = New York Stock Exchange; Philadelphia = Philadelphia Stock Exchange; Pacific = Pacific Stock Exchange; CME = Chicago Mercantile Exchange; NYFE = New York Futures Exchange; KCBT = Kansas City Board of Trade; CBT = Chicago Board of Trade; CSCE = Coffee, Sugar, and Cocoa Exchange; COMEX = Commodity Exchange; MACE = Mid America Commodity Exchange; NYCE = New York Cotton Exchange; MGE = Minneapolis Grain Exchange.

a. Options that trade on a monthly and quarterly cycle are denoted M/Q. The nearest three months plus a six-month maturity are usually available for trading. b. Number of different expiration months trading at any time. These are the nearest months.

c. I = value of index. d. Delisted May 18, 1984. e. Contract size increased from $20,000 to $100,000 on June 20, 1983.
f. Contract size increased from $200,000 to $1 million on June 20, 1983. g. Delisted in 1983.
Sources: Commodity Futures Trading Commission, various exchanges, and Wall Street Journal.
ment (Treasury bonds) and on a short-term debt instrument (ninety-day Eurodollar deposits). By far the most successful of all futures options is the T-bond futures option introduced in October 1982 by the Chicago Board of Trade (CBT). This option contract expires on the first Friday preceding by at least five business days the end of the month before the futures expiration month. Options on Eurodollar futures were only recently introduced by the CME.

In January 1984 the CME introduced options on the West German mark futures. These options expire two business days before the expiration of the futures. In early 1985 options on British pound and Swiss franc futures were introduced.

Futures options in sugar and gold have been available for trading since October 1982. In late 1984 and early 1985 futures options on several domestic agricultural commodities began trading under the CFTC’s second pilot program: live hogs, live cattle, corn, soybeans, cotton, and wheat. Futures options on silver have also begun trading.

**Over-the-Counter Options.** Although our emphasis is on exchange-traded options with active secondary markets, some discussion of over-the-counter (OTC) options, which are also growing in importance, is warranted. OTC options are contracts that are not necessarily standard in striking price or maturity and in which no active secondary market exists. OTC options on individual common stocks existed before the advent of exchange-traded stock options. This market has declined in importance, presumably because the advantage of tailoring options to the needs of a particular investor did not offset the advantages of secondary market trading. OTC options on currencies and on debt instruments appear, however, to have grown in importance with the advent of exchange-traded options in those areas, although there is no hard evidence of the amount of activity in these markets.

Two types of OTC options exist in the bond market: short-term options (limited to 150 days in maturity by regulations of the comptroller of the currency) and long-term interest rate agreements. Government securities dealers, such as the major money market banks, are prepared to write short-term put and call options on particular government bonds with a striking price, maturity, and size tailored to the customer’s needs. Customers with well-defined objectives, who may wish to take delivery of the underlying bond, will find OTC options preferable to exchange-traded options, particularly when the exchange-traded options market is thin.

Interest rate agreements, though not called options, serve the same function as a long-term option contract would. They protect
the borrower against an increase (and the lender against a decline) in interest rates beyond a certain level. Such agreements may last up to ten years. An interest rate agreement could, for example, limit the interest rate paid by a borrower on a floating-rate loan to 14 percent over the period of ten years. If the particular interest rate that is the basis for the floating-rate loan were to rise above 14 percent, the maker of the agreement would pay to the borrower the difference between 14 percent and the market rate. In effect, the borrower is buying a put option, which increases in value when interest rates rise.

Major foreign exchange traders are also prepared to write OTC currency options with terms tailored to the needs of individual customers. Such options are particularly useful for businesses engaged in international trade and planning to make delivery or take delivery of a foreign currency. A striking price, contract size, and maturity tailored to the particular needs of the business are important.

**Functioning of the New Option Markets**

The new option instruments are traded on fourteen exchanges. Nine are futures exchanges: CME, CBT, the Commodity Exchange (COMEX), the Coffee, Sugar, and Cocoa Exchange (CSCE), NYFE, the Kansas City Board of Trade (KCBT), the Mid America Commodity Exchange (MACE), the New York Cotton Exchange (NYCE), and the Minneapolis Grain Exchange (MGE). Four are stock exchanges: NYSE, AMEX, Philadelphia, and Pacific. One, the CBOE, trades options exclusively. There are many similarities but also important differences in the way different exchange option markets operate. In this section we examine how options trading is organized and regulated.

**The Clearinghouse.** Options contracts, like futures contracts, are created instruments. When option buyer and option seller meet, they create a contractual agreement obligating the seller to make delivery at the option of a buyer. The open interest is the number of such contracts outstanding. Options trading is thus quite different from trading in stocks, where a given supply of already issued securities is traded. The clearinghouse is critical to the trading of options contracts because it is their guarantor. After a contract is agreed to, the clearinghouse interposes itself between buyer and seller and, in effect, becomes the party to whom the buyer looks for delivery and to whom the seller must make delivery. Since the number of buyers always equals the numbers of sellers, the clearinghouse always has a zero net position.
<table>
<thead>
<tr>
<th>Time</th>
<th>Buyer</th>
<th>Seller</th>
<th>Premium</th>
<th>Margin Cash Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>B</td>
<td>3.00</td>
<td>A</td>
</tr>
<tr>
<td>2</td>
<td>C</td>
<td>A</td>
<td>2.80</td>
<td>B</td>
</tr>
<tr>
<td>3</td>
<td>C</td>
<td>D</td>
<td>2.80</td>
<td>C</td>
</tr>
<tr>
<td>4</td>
<td>B</td>
<td>C</td>
<td>2.80</td>
<td>D</td>
</tr>
<tr>
<td>5</td>
<td>D</td>
<td>C</td>
<td>3.00</td>
<td>Total</td>
</tr>
</tbody>
</table>

Total: A - 13.00, B - 0.10, C - 0.20, D - 0.00
The clearinghouse and the standardization of options contracts make possible a secondary market in options. An option buyer who does not wish to exercise an option may sell a contract in the same option (that is, with the same maturity and striking price). Since the buyer is now seller of the same contract, the clearinghouse nets out the position. Of course, the buyer could always choose to exercise the option, but most options positions are offset as just described.

In over-the-counter option markets, secondary market trading is not possible, for two reasons. First, there is no clearinghouse; the option buyer must negotiate with the particular option seller with whom the contract was first arranged to undo the contract before maturity. This procedure is cumbersome and also puts the party that seeks to reverse its position at a competitive disadvantage. Second, contracts in the OTC option market are not standardized with respect to maturity month and striking price. Thus, even if a clearinghouse existed, it would be difficult to find traders on the other side willing to trade in very specific instruments. OTC options exist because the tailored contracts are sufficiently attractive to particular individuals to offset the disadvantages of not having a secondary market.

Aside from its clerical role of accounting for contracts and overseeing delivery, the clearinghouse maintains the financial integrity of the options market as guarantor of all contracts. Clearing members post margin deposits to guarantee their transactions, and most exchanges have a guarantee fund of some kind to protect clearing members and thereby customers against a failure of an individual clearing firm.

Each of the futures exchanges has its own clearing organization. Options on the CBOE and the stock exchanges are issued and guaranteed by the Options Clearing Corporation (OCC). Although in principle the existence of the OCC as a common clearing corporation would make possible secondary market trading on one exchange of an option issued by another, none of the new options instruments is traded on more than one exchange.

Secondary market trading in options and the role of the clearinghouse are perhaps best illustrated with the help of a simple example. Assume, as shown in table 4-3, that at the the opening of options trading at time 1, trader A and trader B agree to trade one contract at a premium or price of $3 per unit. (The actual option premium paid will be much larger than this and will depend on the number of units per contract.) Under current arrangements the option buyer, A, pays the premium to the option seller, B. Volume at the end of time 1 is one contract, and open interest—the number of contracts outstanding—is also one. The clearinghouse becomes buyer.
to B and seller to A. When A decides to sell at time 2 to C, the clearinghouse becomes buyer to A and seller to C. Since A is now a buyer and seller of the same contract on the books of the clearinghouse, A’s position is closed out by the clearinghouse. In effect, C replaces A as the offsetting long to B’s short position (without B’s knowledge). At time 2 cumulative volume has increased to two contracts, and open interest remains at one. When C buys a second contract from D at time 3, cumulative volume and open interest increase by one contract. At time 4 and time 5 offsetting positions are entered into, and open interest is reduced to zero. The typical pattern is, in fact, to close out option positions by offsetting contracts rather than by exercise.

**Profits and Margin.** Table 4–3 also illustrates the premium cash flow and margin cash flow associated with option trading. Current institutional arrangements require the option buyer to pay the full premium. At time 1 A pays $3 and B receives $3. The option seller must post sufficient margin to guarantee his obligation to deliver the underlying asset, an amount that is here assumed to be $13. The total cash flow for B is thus $10. At time 2 only A has offset his initial position, and A realizes a profit of $0.10. Option sellers must mark-to-market their margin deposits. Thus B must supply $0.10 to cover the losses from the increase in the option value. At time 3 B can collect profits resulting from a decrease in the option price, and D, a new seller, must post margin, which is again assumed to be $13. Traders A and C, unlike B and D, never hold a short position and are thus never required to supply margin.

That option trading is a zero-sum activity is reflected in the fact that the sum of profits of the four traders is zero. A and B gain; C and D lose. To the extent that margin is pledged in cash, there is a net loss to sellers of options in the form of forgone interest on funds pledged as margins. To the extent that such margin deposits may be made in the form of interest-earning assets such as U.S. government securities, this loss is avoided. To the extent that a broker or a clearing organization demands cash deposits, the broker or clearing organization gains at the expense of the trader.

**Trading Mechanics.** Anyone wishing to trade options opens an account with a brokerage firm. Options on futures contracts are traded in a commodity account, which is subject to CFTC oversight. Options written directly on financial instruments are traded in securities accounts, which are subject to Securities and Exchange Commission (SEC) oversight. Disclosure requirements, broker competency
requirements, insurance of accounts, and other matters related to investors' protection differ between commodity accounts and securities accounts. These issues are beyond the scope of this chapter.\textsuperscript{4}

In options trading, as in trading of other securities, investors can place a variety of orders. A market order instructs the broker to trade at the best price currently available. A limit order instructs the broker to buy at a price below the current market or to sell at a price above the current market price. A stop loss order is an order to sell below the market or to buy above the market. As in futures markets trading, more complex orders may be placed in options markets. Such orders usually involve spread transactions or other simultaneous transactions using more complicated option strategies.

Orders placed by customers with their account executive are transmitted through the brokerage firms to the floor of the appropriate exchange for execution. The mechanics by which such orders are executed can differ markedly among exchanges. Futures options are traded in a trading pit in an "open outcry" format in the same manner as futures contracts.\textsuperscript{5} Options traded on stock exchanges are traded through a specialist in the same manner as common stocks on such exchanges. Options traded on the CBOE combine the features of futures markets and stock market trading mechanics.

In a specialist system market orders are usually traded at the bid or ask price quoted by the specialist, although other traders in the crowd have an opportunity to better the specialist's price. Limit orders are left with the specialist to be executed when the market price reaches the limit price. The bid or ask quotation is sometimes the specialist's own quotation and sometimes the price of the limit order. The specialist system has been criticized because, in most such systems, only one specialist makes a market in each option and investors cannot shop for better prices from other market makers. The CFTC has objected to futures contracts traded in a specialist system on the grounds that the Commodity Futures Trading Commission Act requires the commission to endeavor to take the least anticompetitive means of achieving the objectives of the act.

In a futures system there is no designated specialist. Orders are brought to a trading pit in which many traders trade directly with one another. Traders may act in a dual capacity—as principals for their own account or as brokers for the accounts of customers. Dual trading on futures markets has been criticized. Although CFTC rules prohibit commodity brokers from trading ahead of customers, price reporting statistics are not sufficiently accurate to permit customers to determine whether, in fact, they have received priority: prices are reported only for half-hour intervals or when prices change, and
volume is not reported for individual transactions. The specialist on stock exchanges also trades in a dual capacity, but the volume and price of each transaction are reported. Thus a customer can more readily determine whether an order was properly executed. Futures markets do not guarantee the same degree of price and time priority as stock markets, either because two simultaneous transactions may occur in different parts of the ring at differing prices or because limit orders held by a particular broker are for some reason not exposed to all other brokers in the crowd.

Offset against these apparent disadvantages is the fact that futures markets have many competing professional traders ready to maintain the liquidity of the markets. On futures markets scalpers assume the role of the specialist and are willing to trade their own accounts to offset temporary imbalances in the order flow in much the same way as the specialist does on stock exchanges. The existence of many competing scalpers eliminates the possibility of monopoly pricing by any one of them.

The CBOE system combines elements of futures markets and stock markets. A “board” broker maintains the book of limit orders but does not trade for his own account. At the same time, many professional floor traders are prepared to trade for their own accounts to absorb temporary imbalances as scalpers in futures markets do. More than either the futures market system or the specialist system, the CBOE floor trading system constitutes a kind of trading system that many have called for in the stock market, for it combines competition among market makers with full exposure of all limit orders through the open book of the board broker.6

Each of the markets in which the new options instruments are traded is, however, faced with its own cost of establishing trading systems and burdened with its own history of trading procedures. One should not, therefore, be too quick to impose a system judged to be superior in the absence of a careful analysis of the costs of achieving it. An interesting feature of the new option instruments is that similar instruments are being offered by different exchanges. Investors can trade options in those markets that are judged to offer the best service. Competition among various exchanges may thus be the best means of determining the most efficient trading system.

Costs of Trading. To the options investor the costs of trading consist primarily of two components: the commission charges of the broker and the price concession that may be necessary to execute the transaction. The price concession reflects the fact that sales are made at the bid price of professional traders on the floor and purchases are
made at the higher ask price of professional traders on the floor. On the average the option investor can expect to pay the bid-ask spread in a full-turn transaction. Commission charges are competitively determined and vary from broker to broker. They cover the services provided by the broker as well as charges for floor brokerage and clearing of transactions. In general, commission charges to trade a futures option contract are the same as commission charges on the underlying futures contract, but both are much less than commission charges to trade the contract amount of the underlying asset.

**Regulatory Jurisdiction.** Primary responsibility for regulation of trading in the new options instruments rests with the CFTC and the SEC. The SEC, created in 1934, has primarily been concerned with regulating trading in stocks and bonds issued by corporations. U.S. government securities markets are not subject to SEC jurisdiction and are not formally regulated, although the Federal Reserve and the Treasury monitor this market. Municipal bond markets have been subject to SEC regulation since 1975. Trading in options on common stocks has been regulated by the SEC since secondary market option trading began on the CBOE in 1973. Trading in OTC options, which has existed for many years and continues to exist, has not been regulated by the SEC. The CFTC, created in 1974, was given a broader regulatory mandate than its predecessor, the Commodity Exchange Authority (CEA): to oversee trading in all futures contracts, including futures on nonagricultural commodities previously unregulated by the CEA.

The development of financial futures contracts and new options instruments has generated jurisdictional conflicts between the SEC and the CFTC. Some of these conflicts were resolved by the accord of December 7, 1981, which affirmed CFTC jurisdiction over all futures trading, including futures on debt instruments (except for municipal securities), stock indexes, and currencies. Futures on stock indexes, however, were to be restricted to broad-based indexes settled in cash and not readily subject to manipulation. Specific guidelines for implementing these restrictions were put forth in early 1984 by the CFTC. The accord gave the CFTC jurisdiction over all options on futures contracts subject to CFTC jurisdiction. Options written directly on foreign currencies are also subject to CFTC jurisdiction if they are not traded on a national securities exchange subject to SEC regulation. (The currency options on the Philadelphia Stock Exchange, which is a national securities exchange, are subject to SEC jurisdiction.)

The SEC has no jurisdiction over futures contracts, but the accord
establishes SEC jurisdiction over options written directly on financial instruments (on which futures and options on futures may also exist). Thus the SEC has jurisdiction over options written directly on debt securities, stock indexes, and currencies (traded on national securities exchanges). Furthermore, with respect to options on stock indexes, no restrictions on the characteristics of the index apply. Options on physical assets listed in table 4–2 are subject to SEC jurisdiction; options on futures listed there are subject to CFTC jurisdiction.

It is unlikely that the accord, which was incorporated into the Futures Trading Act of 1982, will resolve all jurisdictional disputes. In particular, the requirement that futures on stock indexes be restricted to broad-based indexes is already the subject of a suit by the Chicago Board of Trade, which challenges the procedures by which the guidelines were set and questions their arbitrariness. In addition, other futures or options instruments not covered by the accord may be developed and may test it. For example, jurisdiction over futures on individual common stocks and options on such futures is not clearly spelled out.

A more fundamental issue arises from the fact that responsibility has been allocated between the SEC and the CFTC for legal, not economic, considerations. It is already evident that very similar economic instruments (for example, options on T-bonds and options on T-bond futures) are regulated by different agencies. The issue, then, is whether similar economic products should be regulated by the same agency or whether regulatory competition has benefits akin to the benefits of competition in the private sector. One objective of this study is to examine the extent to which the new options contracts are similar and to consider the implications of disparate regulation of similar products.

**Economic Purpose of Options**

**Functions of Options.** Options, like futures, are a means of dealing with uncertainty. Indeed, the growth of the new options instruments can be ascribed in part to the increased volatility of the stock market, bond market, and foreign exchange markets in the past few years. Because options have different payoffs from futures, they can be a more useful risk management tool.

In this section we examine the functions of options, as contrasted with futures, as a hedging tool and as an investment tool. Options are a hedging tool insofar as they are used to reduce or eliminate an underlying business risk associated with producing and marketing a product or providing a service. Options are an investment tool
insofar as they are used to modify the risk and return characteristics of an investment portfolio. In this context, as in the hedging context, options can be used to reduce risk. We restrict the term "hedging," however, to cases in which options are used to offset more fundamental business risk, rather than to tailor the risk characteristics of an investment portfolio.

**Options as a hedging tool.** Options are an appropriate hedging vehicle whenever an underlying business risk itself has the characteristics of an option, that is, a commitment by one party that may or may not be rejected by another.

Suppose a U.S. company makes a bid in German marks to install a computer system for a German company, and suppose the German company has the option of accepting or rejecting the bid within one month. During that month the U.S. bidder faces a quantity risk and a price risk. First, the company does not know whether the bid will be accepted and thus does not know the quantity of contracts it will be working on. Second, it does not know the dollar value of the deutsche mark (D-mark) contract if the bid should be accepted. In this situation a D-mark currency option is a better hedge than a D-mark currency futures. By purchasing a put option on the D-mark, the company guarantees the price at which D-marks can be sold if the bid is accepted; if it is rejected, the put option is not exercised. Selling a D-mark futures contract provides a hedge if the bid is accepted, but if it is rejected, the futures contract could be met only by buying the futures at a later date. This would expose the U.S. company to the risk of an increase in the dollar price of the mark.

Farmers also face a combination of price and quantity risk. Before the harvest the farmer does not know the size of the crop or the price. Selling futures against the crop would hedge the farmer against a price decline if the harvest were known, but a futures hedge would expose him to risk if the harvest failed and prices increased. The farmer would take a loss in covering the futures contract, which would not be offset by a corresponding gain on the actual commodity, because of the failure of the harvest. Buying a put option on the underlying commodity provides a more effective hedge against price and quantity risk than selling futures. If prices fall, the put is exercised (or liquidated at a profit). If prices rise, the put option expires worthless, and the farmer can realize the revenues from his crop whatever the size of the harvest. The cost of this one-sided protection for the farmer is the put option premium.

Lending commitments at fixed interest rates also have the characteristics of an option and can therefore be more effectively hedged
in options markets than in futures markets. Suppose a bank makes a mortgage loan commitment of $1 million at 14 percent to finance a project the terms of which are not yet fully complete. Such a commitment might be outstanding for a month or two. If interest rates rise, the loan commitment will be "taken down," and the bank, if unhedged, will suffer the costs of borrowing funds at a higher rate. If interest rates fall or the project is unsuccessful, the commitment will not be taken down. By buying a put option on a T-bond, the bank can protect itself against an increase in interest rates; for if interest rates rise (and bond prices fall), the profit on the put will tend to offset the loss on the loan commitment. If interest rates fall, the put will not be exercised. Interest rate futures would be less effective. Selling interest rate futures would yield a gain if interest rates were to rise, but a loss would occur if interest rates fell. A put option prevents that loss.

Stock index options and options on individual stocks can provide useful hedges to investment bankers who make commitments to buy at a fixed price the shares of a company for resale in a public offering. Suppose an underwriter makes a commitment to purchase at a price of $18 per share 100,000 shares currently selling at $20 per share. The commitment is outstanding while the public offering is being prepared and the regulatory requirements are being met. The underwriter seeks protection against a price decline below $18 but is not concerned about a price increase, in which case the stock will be sold in the public offering. The purchase of a put option provides the necessary protection.

Ideally, a put option on the specific stock should be purchased, but if options in the stock do not exist, the purchase of a put option on a stock index can provide partial protection against a price decline in the individual stock since price movements in individuals stocks and in the market as a whole are generally positively correlated. The hedge ratio—the ratio of the puts purchased to the size of the offering—can be adjusted to reflect the systematic relation between the price of the stock and the index. If a $1 change in the index is usually accompanied by a $2 change in the stock price, for example, options on $3.6 million worth of the index should be purchased to hedge the commitment to purchase $1.8 million worth of shares. Because price changes in the index and the individual stock may not, in fact, be in a one-to-two ratio, a considerable amount of basis risk may continue to exist, but that is true of any cross hedge.

The examples presented illustrate that options not only provide insurance against price risk that is conditional on an event (receiving
the bid, having a successful harvest, making the loan, making the
stock offering) but also avoid any penalty if the event does not occur
(the bid is rejected, the harvest is poor, the loan is not taken down,
or the stock issue is not sold). It is in this sense that options provide
protection against both price and quantity risk and are, therefore, a
better hedging tool than futures contracts in some cases. The insur­
ance provided by an option is, of course, not free since a premium
must be paid to purchase the option. In futures contracts risks to
buyers and sellers are symmetric, and no premium changes hands.
The purchaser of an option must therefore consider whether the risk
that is being avoided warrants the premium that must be paid.

It is not accidental that our illustrations of options hedging have
involved the purchase of put options. In most cases hedges are used
to provide protection against price declines on existing positions.
Hedging with the purchase of call options, however, can also be
useful in locking in the price of an input. A U.S. importer may wish
to lock in the price of deutsche marks needed to purchase a good
being imported from Germany. A lending institution that makes a
commitment to pay a fixed interest rate would find it desirable to
buy call options on debt instruments and would thereby protect itself
against a decline in the interest rates at which the funds it receives
can be reinvested.

The usefulness of options as a hedging tool, like that of futures,
depends on the degree to which the price behavior of the option
mimics that of the underlying commitment. If the association between
the behavior of the option and the underlying commitment is not
perfect, basis risk exists. The existence of over-the-counter options
can be explained by the desire of certain hedgers to avoid this basis
risk and to purchase an option that is more directly tailored to the
specific needs of the hedger. OTC markets in bond options have
grown in recent years. By providing greater flexibility in option matu­
rity, striking price, and the underlying bond against which the option
is written, OTC bond options can be a more useful hedging instru­
ment than exchange-traded options. Similar reasons explain the exist­
ence of OTC currency options. The growth in OTC bond and currency
options has coincided with the growth in exchange-traded bond
options and exchange-traded currency options. These markets are
complementary for two reasons. First, both buyers and writers of
OTC options can use the prices of exchange-traded options as pricing
guides in their negotiations. Second, writers of OTC options can
hedge their positions in the exchange-traded option markets (though
imperfectly).
Options as an investment tool. The new options can also serve an important function as an investment tool for investors or financial institutions responsible for managing investment portfolios. Options provide a means of increasing or limiting risk in a manner consistent with investors' expectations and attitudes toward risk. They can also facilitate changes in portfolio composition or reduce the costs of achieving certain positions. It is beyond the scope of this chapter to consider the full range of option strategies available to investors. These are discussed in detail in a variety of books, articles, and investment literature. Our purpose here is more limited: to provide some examples and some understanding of the investment uses of options.

The principal benefit of options as an investment tool is that they allow the investor to generate nonlinear profits as a function of changes in the price of the underlying asset, which cannot readily be done by trading the underlying asset or futures on the underlying asset alone. Payoffs to the underlying asset or to futures contracts on the underlying asset are linear in the asset's price, as shown in figure 4–1. Options permit losses to be limited (at the cost of the premium) or limit gains (in return for a premium). Combinations of options can limit the range over which profits are earned or losses incurred. Thus a long position in an underlying asset or a futures contract on that asset exposes the investor to losses if the asset price falls. The purchase of a naked call option produces the same upside potential as ownership of the underlying asset but avoids potential losses (as shown in figure 4–2). Similarly, short positions in the underlying asset or the futures contract expose the investor to losses if the underlying asset price rises; the purchase of a naked put protects the investor against a rise in the asset price while generating profits if the price falls (see figure 4–3).

Investors holding a portfolio of assets, such as stocks and bonds, can use options to modify the payoffs to the underlying assets so as to produce nonlinear payoffs that restrict or expand risk. Consider a portfolio of bonds. The purchase of puts on T-bond futures would provide protection against a fall in bond prices without eliminating the potential profit from a rise in the price of the bonds in the portfolio. This strategy, which creates a synthetic call position in the underlying bonds, would be sensible if the portfolio manager expected a temporary decline in bond prices. (The degree of protection would depend on the degree of correlation between the price movements of T-bond futures—on which the option is written—and the price movements of the bonds in the portfolio.) The portfolio manager could, of course, sell the bonds, but this can be difficult or costly.
An alternative strategy is to write call options against the bond portfolio to earn premium income. This strategy eliminates the possibility of a gain from an increase in bond prices and would be appropriate if the investor believed that bond prices would be relatively stable over the near future. In effect, writing call options against a position in the underlying asset is like writing naked puts, since the investor stands to lose from price declines and makes no profit from price increases.

The availability of options on a variety of underlying assets permits the investor to purchase protection for various components that may influence the performance of a portfolio. The manager of a portfolio of common stocks, for example, may wish to protect that portfolio against a general decline in the stock market without giving up the benefit of a market increase. This objective can be met by purchasing put options on a broad-based index. Purchasing put options on individual stocks is also possible but might be time consuming and costly, and options on many stocks are not available. Furthermore, the manager may believe that the stocks in the portfolio will outperform the market as a whole. If puts on the index are purchased, the potential gain if the individual stocks decline less than the index is not eliminated.

Alternatively, the investment manager may be concerned about the adverse effects on a portfolio of common stocks of an increase in interest rates but willing to accept the risk of other factors that might cause stock prices to decline (for example, lower corporate earnings). Purchasing put options on debt instruments would provide protection against this risk. Selling interest rate futures could provide some of the same protection, but at the risk of loss if bond prices should rise.

These simple examples illustrate two fundamental motives for using options. On one hand, investors anticipating increased volatility in the price of the underlying asset will wish to buy protection for an existing position (buy puts against the long position, calls against the short position) or, alternatively, to purchase naked options. On the other hand, investors anticipating decreased volatility in the price of the underlying asset will wish to sell protection and earn premium income. That is, they will be willing to write naked calls or puts or to write calls against a long position (a synthetic put) or puts against a short position (a synthetic call).

More complicated option positions than those just illustrated are available. Some of these entail spreading put or call options with different exercise prices or different maturities. A money spread, for example, entails the purchase of an option at one exercise price and
the sale of an option on the same underlying asset at a different exercise price. The purchase of a call option on the S&P 500 index at a striking price of 150 and the sale of a call option on that index at a striking price of 160 is a bullish money spread. The spread makes money if the index rises but eliminates any gain above 160; it also eliminates any losses below 150. The corresponding bear money spread would entail the sale of a call option at 150 and the purchase of a call option at 160. This spread makes money if the price of the underlying index falls but limits profits at 150 and losses beyond 160. A time spread entails the purchase or sale of an option of one maturity and the sale or purchase of an option on the same underlying asset at a different maturity.

Other complicated options positions combine puts and calls on the same underlying asset. A long straddle, for example, entails the purchase of a put and a call with the same exercise price. Such a position makes money if the price of the underlying asset either increases or decreases greatly and loses money if the underlying asset price remains the same. A strangle and a guts involve the same option positions as the straddle and thus have similar payoff contingencies. The only difference between the strategies is that in a strangle the exercise price of the put is less than that of the call and in a guts the exercise price of the put is greater than that of the call.

Options can be useful in managing changes in the composition of an investment portfolio. At times the purchase or sale of an underlying asset may be costly or difficult, perhaps because of illiquidity in that market. The purchase of a call option on the underlying asset or a closely related asset can lock in a price while the underlying asset is being purchased. Similarly, the purchase of a put option can lock in the sale price of an asset while the disposition of the underlying asset is being arranged. In a similar way, options can be helpful to market makers in particular securities by giving them greater flexibility to modify or hedge particular portfolio positions imposed on them by public transactions. The availability of options can reduce the risks assumed by the market maker and can therefore improve the depth of markets and reduce the costs of providing the services of market making.

Social Benefits and Costs of Options. Social benefits. The benefits to society of options trading are similar to the benefits of other financial markets, such as the bond market, the stock market, and futures markets. First, options are a means of allocating risk. Second, trading in options provides price information that is useful in allocating resources in the economy. Third, the new options markets may lower
the transaction costs of trading in the financial markets below the costs of trading existing financial instruments.

An important social benefit of options is their usefulness in shifting risk from one individual to another, both business risk and investment or portfolio risk. Options can make it possible to buy protection against certain business risks (price and quantity risk) and thereby allow a business to concentrate more fully on those areas of activity at which it is most expert, thus facilitating specialization and efficiency in productive activities. Options also provide greater flexibility in structuring the risk-return composition of a portfolio and permit investors to pass off certain risks to other investors more willing to bear them. Although there is no direct connection to productive activity in this case, options thus increase the utility of investors.

Some trading in options markets, as in other financial markets, arises not because individuals have a desire to shift risk but because they have different information and disagree about the correct price of the option. This kind of informational trading may also be termed speculative trading. Society benefits from speculative trading because the analysis and search for information on which it is based cause the prices of options to correspond more closely to their correct value. Prices that are "correct" in this sense ensure that prices are fair, allocate risk correctly, and give proper signals for productive activity in the economy.

The way in which disagreement produces options trading can be illustrated by the following example. Consider an underlying asset selling at $50. If both the option writer and the option buyer agree that there is a 50 percent chance of the asset's going to $60 and a 50 percent chance of its staying at $50, they will both agree that the actuarial value of an option with a $50 exercise price is $5. If the writer is averse to risk, he will demand slightly more than $5; if the buyer is averse to risk, he will only be willing to pay less than $5. As a result, no trade will take place even in the absence of transaction costs. A trade will take place if the writer and buyer disagree by sufficient amounts about the actuarial value of the option. If the buyer believes that the actuarial value is $6 and the writer believes that it is $4, a trade will take place. Assume that that trade is at $5. Permitting the writer and the buyer to trade at $5 makes both better off because it raises the expected income of each by $1. Of course, after the fact, neither may profit, or one may profit and the other lose.

From the point of view of society, informational trading in options is beneficial because it is likely to increase the interest and the number
of judgments bearing on the underlying asset's price. Since option prices are related to the price of the underlying asset by an arbitrage relationship, factors affecting option prices tend to be conveyed to the price of the underlying instrument; conversely, factors affecting the price of the underlying instrument tend to be conveyed to option prices. Thus, to the extent that option trading in a given asset increases the total interest in that asset (asset plus option interest) and the total number of judgments about the asset's value, the asset price will be more broadly based and less susceptible to a few judgments.

A related benefit to society is that an option market encourages specialization of research and analysis, which leads to greater efficiency in the production of information if the securities analysis industry is like other industries. Since option values depend in an important way on the projected volatility of the underlying instrument, an option market creates an incentive to investigate and to project correctly future uncertainty. A superior analyst could, for example, profit by writing calls on assets believed to be less volatile than implied by the current price of those calls and buying calls on assets believed to be more volatile than implied by their current price. The analyst's trading strategy will be based on an analysis of the risk of each underlying asset, which depends on an understanding of the fundamentals affecting the asset's value as well as general economic and regulatory factors that may affect value. The result of such analysis will cause option prices more accurately to reflect projected uncertainty about an underlying asset's value. This kind of information is also reflected in the price of the underlying asset, but the option price in relation to the price of the asset depends critically on the market's judgment about the future volatility of the asset's price.

Because price changes in options are directly related to price changes in the underlying asset, options are sometimes called redundant assets. This view implies that options provide no social benefits, because any portfolio position achievable with options can be achieved by appropriate trading of the underlying asset. The existence and social benefits of certain options depend, then, on the savings in transaction costs that they provide. The down-side protection that the purchase of a put option provides could also be provided by instructing the broker to sell the underlying asset at the striking price of the put; that is, to give the broker a stop-loss order where the stop price is the same as the exercise price of the put.

The stop-loss order, however, has several drawbacks in comparison with the purchase of a put. First, the transaction costs of trading the underlying asset—the commission and the bid-ask spread—are
greater than the cost of trading the option. Second, the stop-loss order may be executed at a price somewhat below the stop price since a stop order becomes a market order when the market reaches the stop price. Third, the stop order will be executed if the price of the underlying asset reaches the stop price, whereas the put option need not be exercised and can continue to provide protection even if it is not exercised. The put option thus gives the investor the opportunity to stay fully invested. If the underlying asset is sold, the reinvestment of the proceeds generates additional transaction costs. Put and call options can thus provide social benefits by saving transaction costs or otherwise making it easier to accomplish certain investment objectives. The growth of options in common stocks and the advent of the new options instruments imply that the objectives of options cannot be provided at the same transaction costs by trading in the underlying asset.

Social costs. Options trading in the United States has had a checkered history and has at times been prohibited on a variety of grounds. Options on common stocks and commodities were traded in the 1920s and 1930s before option markets were formally regulated. The Commodity Exchange Act of 1936 banned trading in options on all domestic agricultural commodities regulated by that act. The ban reflected a congressional concern that options trading would destabilize commodity prices. The SEC, though not banning stock options outright, urged securities exchanges to prohibit members from trading securities in which they also traded options. Such regulations were passed, with the result that options were for many years not traded on national securities exchanges. Today those national securities exchanges on which stock options are traded (AMEX, Philadelphia, Pacific) do not permit specialists to make markets simultaneously in options and in the underlying stocks.

Objections to options markets are of three kinds. First, the benefits are questioned on the grounds that options trading is a form of gambling that does not, as argued in the preceding section, contribute to price formation and the allocation of resources. Second, the benefits of option trading are not disputed in principle, but their existence in practice is questioned; there is concern that options markets operate to the disadvantage of unsophisticated investors. Third, options are said to have certain adverse external effects even if they operate efficiently and fairly.

Some critics argue that options trading is a form of gambling that does not contribute usefully to the allocation of resources in the economy, although it may provide enjoyment for some participants.
In this view options trading is a bucket shop—a series of side bets—with respect to the underlying assets and the functioning of the underlying economy. Futures markets and the stock market are at times also viewed in this light.

As argued in the preceding section, however, even if options trading is purely speculative—based on disagreements among traders—it has social benefits. A useful distinction between speculation and gambling is that gambling entails the assumption of created risks (for example, roulette, poker) and speculation the assumption of natural risks (for example, droughts, uncertainty of aggregate output, and interest rates). In this sense trading in the new options instruments is speculation, not gambling, because it involves the assumption of underlying risks in the economy that generate price volatility in bonds, stock indexes, and commodities. The arguments in favor of options markets are, to a large extent, the arguments in favor of speculation, and the arguments against options markets are the arguments against speculation. The arguments against are that speculators cause prices to deviate from true underlying values. The arguments in favor are that speculators cause prices to move toward underlying values because doing so is profitable. Options have benefits that go beyond the benefits of speculation since they have hedging uses directly related to productive activities in the economy.

A second concern about options arises not out of any belief that options have no social value but out of the belief that options trading can be abused to benefit professionals at the expense of unsophisticated traders. A study by Mehl of trading in agricultural options examines some of these issues, and a special study of options markets by the SEC in 1978 considered trading abuses in options on common stocks. Three types of trading abuses were identified by the SEC study.

The first of these is artificial trading, in which professional traders report fictitious trades or enter into prearranged transactions among themselves: transactions between two individuals that they know will be reversed at the same price. Artificial trading may arise to create the impression of volume or to register an option price that conforms more closely to the price of the underlying instrument. Artificial trading is undesirable insofar as it creates the impression of liquidity where none exists and thereby attracts public orders that will be poorly executed. This kind of abuse is most likely to occur when several markets are trading in competitive instruments and thus create a special incentive to inflate volume figures.

A second abuse is the capping or pegging of the price of the underlying asset with respect to which an option is written. A writer
of call options would like to cap the price of the underlying asset at or below the exercise price to avoid having to deliver the asset at a loss and to profit by any decline in the price of the call option. Capping would be accomplished by selling the asset itself. Similarly, the writer of a put option would like to peg the price of the underlying asset at or above the exercise price to avoid purchase of the asset at a loss and to profit by any decline of the price of the put. This would be accomplished by buying the asset. Thus the ability to establish an unjustified price of the underlying asset—to manipulate the price—is critical to capping and pegging. The ability to manipulate the underlying asset's price need not by itself be profitable, however, since profits on the option position could, in principle, more than offset losses in the asset.

The depth of the underlying market and the presence of other traders that could profit from an unjustified price limit manipulation. The sale of an underlying asset to cap the price would do little to lower the price given the presence of other knowledgeable traders that would provide depth to the market. In this case a manipulator puts himself in a very risky position: short the underlying asset and short call options on it. An increase in the price of the asset caused, for example, by the arrival of new information would generate substantial losses. An important defense against manipulation is thus the presence of a large number of traders with ready access to the market. The new options instruments tend to be written on underlying assets for which the markets are broader and deeper than the markets for many of the individual stocks in which options are also written. They are therefore less subject to manipulation than many assets already trading.

The issue of the manipulation of the prices of financial instruments must be viewed in perspective. Manipulation is, in principle, possible in any market; but it is also very difficult because (1) manipulating prices through heavy buying or selling tends to produce an opposite movement in prices when a position is reversed and (2) a manipulated price is an unjustified price that creates profit opportunities for other traders. Manipulation based on trading activity alone therefore tends to be held in check by competing traders. The existence of options trading increases the number of traders interested in determining the correct price of the underlying asset. Through arbitrage links between the option and the asset, the liquidity of the asset is increased and the manipulation made more difficult.

The role of government regulation in limiting manipulation should also be viewed in perspective. Although legal prohibition of manipulative practices is important, particularly insofar as those practices
OPTION MARKETS

are fraudulent, regulatory oversight is not adequate to detect many unjustified price movements resulting from trading activity alone. Many of those movements are smaller than the transaction costs of nonprofessional traders. Important regulatory objectives should be to see that sufficient competing investors, each with an interest in detecting unjustified price movements, are present and to ensure that transaction costs are as low as possible. Competing investors cannot be effective if transaction costs are high and trading in a security is restricted to a few professional traders. Public policy should therefore be aimed at a market structure that minimizes commission rates, bid-ask spreads, and other costs of trading and reduces communication costs. Moreover, exchanges have an incentive to eliminate manipulation since a market in which manipulation is possible does not attract traders.

A third abuse that has recently received considerable publicity is front running. Front running is trading an option in anticipation of a large transaction in the underlying asset. A trader who knows that a large block of stock will be sold that will depress the price of the stock can purchase a put option or write a call option. When the price falls, these options' positions become profitable. Front running thus involves inside market information concerning pending transactions. Trading on market information is, of course, a common practice with or without options. Indeed, most professional traders are in search of such information, and most block traders are therefore secretive about their efforts. Options are not critical to front running since a stock can be sold short in anticipation of a large block sale to accomplish the same objective.

From the perspective of society, the harmful effects of front running are not clear. On the contrary, front running is desirable insofar as it causes securities prices to reflect the information arriving in the market more quickly. The sale of call options on 20,000 shares of stock will convey information not dissimilar to the sale of the 20,000 shares themselves, and it will depress call option prices. The information conveyed by the sale of the call options and the reduced call option price will in turn tend to depress the price of the underlying stock before the actual sale of the stock. From the perspective of market efficiency, this is desirable. The redistribution of income implied by successful front running (from the block seller to the option seller) may, however, be considered unfair. Furthermore, a market in which front running is possible is likely to discourage traders.

A third objection to option markets arises from a concern about adverse external effects on existing markets in the underlying and
related instruments or on other risk-taking activities. Options might shift trading interest from the underlying instruments to the options market and thereby reduce liquidity in the underlying markets. Or options might attract risk-taking capital from other areas of economic activity, such as the new issues market for small firms or the venture capital market.

These issues have been investigated with respect to options trading in common stocks. These investigations and the experience with such trading suggest that it has not had adverse external effects of the kind described. First, options do not involve the shifting of capital. Although premiums are paid in options markets, there is no reason to believe that such premiums are systematically shifted away from investment in underlying assets. Options are primarily a means of shifting risk, not of shifting capital.

Second, although options trading can, in principle, reduce the volume of trading in underlying instruments, evidence and recent experience indicate that it has not done so. The liquidity of trading in individual common stocks has been maintained in the presence of options in those stocks. Even if the volume of trading in the underlying instrument were reduced, liquidity—in the sense that large transactions can be accomplished without affecting the price—need not be adversely affected if the amount of potential volume is great. To the extent that options increase the total interest in a security, potential volume is increased. Furthermore, the existence of options permits risk shifting that can reduce the risk of taking large positions in the underlying asset and thereby increase liquidity. A contradictory objection to options trading sometimes voiced is that it increases congestion of markets when options positions are closed out or various hedge positions are offset. But such activity increases volume and should be desirable from the perspective of increasing liquidity.

According to Robbins et al., the concern that options trading detracts capital from new issues is unwarranted. Indeed, options do not shift capital. They may provide a useful service in broadening the range of high-risk investments available to investors. This is desirable because there is considerable academic evidence that excessive buying of new issues sometimes forces their prices to unwarranted levels.

Option Pricing

We have argued that options markets can enhance the depth and liquidity of underlying asset markets by increasing the number of
judgments bearing on the value of the underlying asset. For this argument to hold, option prices must be closely linked to underlying asset prices so that new information and other factors causing prices to change can be quickly conveyed between option and asset markets. In this section we present the pricing relations linking the underlying asset, the futures, the asset option, and the futures option and summarize the empirical evidence on the tightness of these links.

The pricing relations linking the four markets, depicted by the solid lines in figure 4–5, are maintained by two kinds of trading strategies. The first is a costless arbitrage strategy that leads to the put-call parity relation linking puts, calls, and the underlying item. The second involves hedging the option against the underlying instrument and leads to explicit valuation equations for options in terms of underlying asset prices and certain other factors.

To make statements about the pricing of options, it is useful to introduce certain notation:

\[ S = \text{price of the underlying asset} \]
\[ F = \text{price of the futures contract written on the underlying asset} \]
\[ X = \text{exercise price or striking price of the option} \]
\[ T = \text{time to expiration of the option} \]
\[ r = (\text{continuously compounded}) \text{ riskless rate of interest} \]
\[ b = (\text{continuously compounded}) \text{ constant cost of carrying the underlying asset} \]
\[ c(S,T,X), p(S,T,X) = \text{price of European call or put option} \]
the asset price is $S$, the time to expiration is $T$, and the exercise price is $X$

$$C(S,T,X), P(S,T,X) = \text{price of the corresponding American call or put option}$$

Prices of options on futures contracts are denoted by using $F$ instead of $S$ as the first argument within parentheses.

Certain option pricing results are more easily understood if the relation between the futures price and the underlying asset price is developed. For this reason we present the cost-of-carry model linking the futures price and the asset price at the outset. This is followed by discussions of the links between asset prices and asset option prices, between futures prices and futures option prices, and between asset option prices and futures option prices.

Cost-of-Carry Model. The relation between the futures price and the price of the underlying physical asset is referred to as the cost-of-carry model. To understand this relation, consider two strategies for acquiring one unit of the physical asset on a future date $T$. Under the first strategy, purchase $e^{(b - r)T}$ units of the asset at a cost $S$ per unit, and hold the position until time $T$. The difference between $b$, the total cost of carrying the asset, and $r$, the opportunity cost of tying up funds in inventory ($b - r$), is the component of carry costs reflecting out-of-pocket storage costs, such as warehouse rent, insurance, and spoilage. In this formulation, $b - r$ is the rate at which inventory would have to be sold off to cover the storage costs and leave one unit of the asset at time $T$. Under the second strategy, take a long position in the futures contract and purchase $Fe^{-rT}$ riskless bonds. At time $T$ the proceeds from the futures position, $S_T - F$, are combined with the bond proceeds, $F$, to buy one unit of the asset at price $S_T$. This alternative provides the same inventory at $T$, but for a cost of $Fe^{-rT}$ dollars. Since both strategies have the same terminal values, their initial costs must be equal, that is,

$$Se^{(b - r)T} = Fe^{-rT}$$

which implies

$$F = Se^{bT}$$

(1)

Equation 1 is the relation between the futures price and the underlying asset price in "full carry" market. (The horizontal link across the top of figure 4–5.)

The components of the carry cost, $b$, depend on the nature of the underlying commodity. For an agricultural commodity such as
wheat, the carrying cost includes interest plus storage costs, such as rent, insurance, and spoilage. For the assets underlying the new financial futures contracts, the only carrying cost is interest. Holding a T-bill, for example, involves only the opportunity cost of the funds used to buy it. Occasionally a financial asset underlying the futures contract pays a yield that offsets the interest cost, which results in \( b < r \). The holder of a stock portfolio, such as the S&P 500 stock index, receives dividends that offset the interest cost of funds used to finance the investment. Similarly, holding a T-bond yields coupon interest, and holding a foreign currency yields the foreign interest rate.

Figures 4–6 illustrates the typical cost-of-carry relation as the futures contract approaches expiration. At any time before the expiration of the futures contract, the futures price is greater than the underlying asset price, assuming the total cost of carrying the asset is positive (that is, \( b > 0 \)); at expiration the futures price is equal to the asset price. Both these results are used later in this section.

**Linkage between the Prices of the Asset and the Asset Option.** The pricing links between the asset and the asset option, depicted by the leftmost vertical line in figure 4–5 are now developed. We consider the put-call parity relation, the valuation of asset options in relation to the asset, and empirical evidence on the price links.

**FIGURE 4–6**

**Full Carry Cost between Futures and Asset Prices**

\[
\text{Cost of carry, } \quad F = S e^{bT}
\]
Put-call parity in asset options. Put-call parity is an arbitrage relation derived from the fact that payoffs from a position in the underlying asset can be replicated by a position in puts, calls, and riskless bonds. The profit diagrams in figure 4–4 show, for example, that it is possible to generate a long position in the underlying asset by buying a call and selling a put. When alternative positions yield the same payoffs, their prices must equal; otherwise arbitragers could profit risklessly by selling the overvalued asset or portfolio and buying the undervalued asset or portfolio.

The precise nature of the put-call parity relation depends on whether the options are European (that is, can be exercised only at expiration) or American (can be exercised at any time up to and including expiration). The primary focus of this chapter is on American options since they are the only type traded in the United States; however, it is useful to develop put-call parity for the simpler European option and then extend the result to American options. In this way the mechanics of the costless arbitrage transactions can be better understood.

Put-call parity for European options on physical assets may be derived by considering a portfolio created by (1) buying \( e^{(b - r)T} \) units of the asset at a cost of \( Se^{(b - r)T} \); (2) buying a put option at a cost of \( p(S,T,X) \); (3) selling a call option with the same exercise price as the put for proceeds, \( c(S,T,X) \); and (4) borrowing \( Xe^{-rT} \). At the expiration of the options, the value of this portfolio is equal to zero because the asset position will have deteriorated (or increased) in value to \( S \), the long put–short call position will have the value \( X - S \), and repayment of the borrowing will require a cash flow of \(-X\). In efficient capital markets the initial value of the portfolio must also be equal to zero, or

\[
c(S,T,X) - p(S,T,X) = Se^{(b - r)T} - Xe^{-rT}
\]

It is interesting to note that when the current asset price is equal to the exercise price of the options (that is, \( S = X \)), the difference between the call and the put price is

\[
c(S,T,X) - p(S,T,X) = S(e^{rT} - 1)e^{-rT}
\]

the present value of the cost of carrying the underlying asset to the expiration of the options.

If put-call parity is violated, a trading strategy can be used to earn an arbitrage profit. Consider, for example, options written on the S&P 100 stock index. Suppose the current index price is 100 and the call and put options with an exercise price of 100 and three months to expiration are priced at 2.50 and 1.50, respectively. If the
riskless rate of interest is 12 percent annually and the dividend yield on the S&P 100 is 6 percent annually, put-call parity is violated because

\[ 2.50 - 1.50 < 100e^{-0.06(25)} - 100e^{-0.12(25)} = 1.47 \]

The appropriate strategy to implement here is a conversion: buy a call, sell a put, sell the stock portfolio, and invest the proceeds at the riskless rate of interest. Such a strategy will ensure a riskless profit of \( 1.47 - 1.00 = 0.47 \). Arbitragers taking advantage of such profit opportunities ensure that relation 2 holds.

The put-call parity relations for American options written on physical assets, developed by Stoll and Whaley, \(^{23}\) are

\[ S - X \leq C(S,T,X) - P(S,T,X) \leq Se^{(b-r)T} - Xe^{-rT}, \quad \text{if } b \geq r \quad (3) \]

and

\[ Se^{(b-r)T} - X \leq C(S,T,X) - P(S,T,X) \leq S - Xe^{-rT}, \quad \text{if } b < r \quad (4) \]

Here the equality of the European option relation has been replaced by two inequalities because the American options may be exercised early and therefore have early exercise premiums built into their market prices. \(^{24}\) The conversion and reverse conversion trading strategies used to derive relations 3 and 4 are the same as those used to derive the European put-call parity relation, except that the amounts invested in the physical asset and the riskless bonds change, depending on the nature of the asset-option price configuration. \(^{25}\)

**Asset option valuation.** The asset option and the underlying asset are also linked because options are valued in relation to the underlying asset value. The development of asset option valuation equations requires an assumption about the nature of the underlying asset's price distribution, and the most common assumption is that the distribution is log normal. Under this assumption and the assumption that a riskless hedge may be formed between the option and the underlying asset, Black and Scholes derive the valuation equation for a European call option written on a non-dividend-paying common stock. \(^{26}\) The fact that the stock does not pay dividends makes the carry cost of holding the stock equal to the riskless rate of interest \( (b = r) \). Asay notes that the Black-Scholes model is easily extendable to the case in which the underlying instrument is any physical asset with a continuous cost of carry \( b \), not necessarily equal to the interest rate, \( r. \) \(^{27}\) The valuation equation for a European call
option written on an asset is

\[ c(S, T, X) = e^{-rT}[e^{bT}SN(d_1) - XN(d_2)] \]  

(5)

where \( d_1 = \frac{\ln(S/X) + (b + 0.5\sigma^2)T}{\sigma \sqrt{T}} \); \( d_2 = d_1 - \sigma \sqrt{T} \); \( \sigma \) is the standard deviation of the asset's rate of return; and \( N(.) \) is a cumulative standard normal density function with upper integral limit \( d \).

Although the formula appears technically complex, its meaning is fairly straightforward. At expiration the call option is worth zero if it is out of the money \((S_T \leq X)\), and it is worth the asset price less the exercise price, \( S_T - X \), if it is in the money \((S_T > X)\). The expected terminal call price is therefore equal to the expected difference between the asset price and the exercise price, conditional upon the option terminating in the money times the probability that the option will expire in the money. Equation 5 merely quantifies this value. The term \( Se^{bT}N(d_1) \) is the expected terminal asset price conditional upon the option finishing in the money times the probability that the option will finish in the money, while \( XN(d_2) \) is the cost of exercising the option times the probability that the option will be exercised at expiration. The discount factor, \( e^{-rT} \), merely brings the expected terminal value of the option back to the present.

The European call option valuation equation specifies the call as a function of six variables: the asset price \((S)\), the exercise price \((X)\), the time to expiration \((T)\), the cost of carry \((b)\), the riskless rate of interest \((r)\), and the standard deviation of the underlying asset's returns \((\sigma)\). The call price increases with the asset price, the time to expiration, the cost of carry, the riskless rate of interest, and the standard deviation of the asset’s return and decreases with the exercise price of the option. Changes in the asset price will, by equation 5, be reflected in the option price; similarly, changes in the option price will be reflected in the asset price.

The European put option valuation equation may be derived by substituting the European call formula, 5, into the put-call parity relation, 2. The resulting equation is

\[ p(S, T, X) = e^{-rT}[XN(-d_2) - e^{bT} SN(-d_1)] \]

where all notation is as it was defined for the call.

The American option valuation equations are too cumbersome to be presented here; however, it is useful to recall that the difference between American and European option prices results from the fact that American options have an early exercise privilege. The value of this privilege varies with the characteristics of the option. Below are
some simulated European and American option values intended to illustrate how valuable the early exercise privilege may be.

<table>
<thead>
<tr>
<th>Stock Price</th>
<th>European Call ( c(S,T,X) )</th>
<th>American Call ( C(S,T,X) )</th>
<th>European Put ( p(S,T,X) )</th>
<th>American Put ( P(S,T,X) )</th>
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<td>20.22</td>
<td>0.13</td>
<td>0.13</td>
</tr>
</tbody>
</table>

The values are based on the following parameters: \( X = 100, b = 0.02, r = 0.10, \sigma = 0.20, \) and \( T = 0.25. \) Such values might be reasonable for three-month options written on the S&P 100, where the index pays a dividend yield of 8 percent annually. For calls the European and American valuations are identical in this example, but a difference arises for puts. As one would expect, an American put is more valuable than a European put because of its early exercise feature.

Empirical evidence on the price links between assets and asset options. In efficient markets securities prices reflect underlying values. Asset options are linked to the value of the underlying asset by the put-call parity relation such as equation 2 and by valuation equations such as 5. Empirical tests of option market efficiency are tests of the degree to which these links are observed in actual markets—the degree to which options reflect underlying value as described by equations like 2 or 5. Some empirical results for stock options as well as the available evidence on the new options are summarized here.

The earliest test of put-call parity by Stoll examined weekly prices of over-the-counter options written on twenty-five stocks during the period January 1966 through December 1967.\(^28\) Stoll did not examine the profitability of the trading strategy directly but performed various tests to verify the structure of the European put-call parity relation. His conclusion was that put and call option prices were linked to each other and to the underlying stock price by the put-call parity relation.

Klemkosky and Resnick examined the American put-call parity relation using transaction data for CBOE stock options during the period July 1977 through June 1978.\(^29\) They determine violations of put-call parity and set up appropriate arbitrage positions to attempt to profit from the violation. A total of 606 positions were constructed during the period. Only 27 percent were profitable after a $20 trans-
action cost was imposed, and only 7 percent were profitable after a $60 transaction cost was imposed. They concluded that the CBOE is an efficient market and that the put-call parity pricing links are well supported within the bounds of transaction costs.

Chin investigated the put-call parity relation for American asset options, using weekly option prices for the West German mark options trading on the Philadelphia Stock Exchange during the period October 1982 through December 1984. He found that only 2 of the 207 arbitrage positions were profitable before transaction costs and that none were profitable after reasonable transaction costs were imposed. He concluded that the West German mark options are efficiently priced, at least with respect to finding costless arbitrage opportunities.

The second category of market efficiency tests involves using an option valuation equation like 5 to identify mispriced options. Underpriced options are assumed to be bought and overpriced options sold in an attempt to investigate whether abnormal profits may be earned. If they can, mispriced options must have existed, and the market is deemed to be inefficient.

The first systematic test of option market efficiency using an option valuation model was by Black and Scholes. The data used in their examination were call option prices for OTC options written on 545 common stocks during the period 1966 through 1969. The model used was the Black-Scholes European call option pricing equation. They found that significantly positive excess returns could be earned by trading on the basis of their model but, once reasonable transaction costs were imposed, the profits disappeared.

Whaley investigated the efficiency of the CBOE, using the American call option pricing equation. On the basis of weekly call option data for the period 1975 through February 1978, Whaley's trading strategy generated a 2.46 percent weekly return. Using the Phillips and Smith estimates of transaction costs for CBOE options, Whaley found that after transaction costs trading profits were eliminated. He concluded that CBOE market efficiency is well supported.

Shastri and Tandon examined the efficiency of the Philadelphia Stock Exchange's foreign currency options market, using transaction data for the period February 1983 through August 1984. The pricing model used was the American asset option valuation equation, where the cost of carrying the currency is the domestic interest rate less the foreign interest rate. No profitable deviations from the pricing model (after transaction costs) were found.

In summary, the empirical tests of put-call parity and asset option valuation indicate that the over-the-counter, CBOE, and Philadelphia
Option markets are efficient and that option prices and asset prices are closely linked. Not even member firms that have low transaction costs can benefit by engaging in arbitrage activities based on put-call parity or a valuation model. The information impounded in option prices appears to be quickly and efficiently impounded in asset prices, and vice versa.

Linkage between the Prices of the Futures and the Futures Options. This subsection is devoted to a description of the pricing links between the futures and the futures option markets (those depicted by the rightmost vertical line in figure 4–5). The discussion is divided into three parts—put-call parity, option valuation, and empirical evidence.

Put-call parity in futures options. The put-call parity relation for European futures options is

\[ c(F,T,X) - p(F,T,X) = e^{-rT}(F - X) \] (6)

To derive this relation, consider a portfolio consisting of a long position in the futures contract, a long position in the put option, a short position in the call option, and a long position of \((F - X)e^{-rT}\) riskless bonds. The terminal value of this portfolio is equal to zero because the futures contract will have a value \(F_T - X\) and the long put–short call position will have a value \(X - F_T\). As a result the initial net investment cost must also be equal to zero; otherwise costless arbitrage profits could be earned. If the net investment is equal to zero, then equation 6 must hold.

Note the similarity between the put-call parity for European futures options (equation 6) and the put-call parity for European asset options (equation 2). If the futures price, \(F\), from the cost-of-carry relation (1) is substituted for \(S e^{bT}\) on the right-hand side of (2), the right-hand side of (6) is obtained. The intuition here is that the futures price in (6) impounds the cost of carrying the underlying asset, which appears explicitly in (2).

Put-call parity for American futures options, derived by Stoll and Whaley,35 is

\[ F e^{-rT} - X \leq C(F,T,X) - P(F,T,X) \leq F - X e^{-rT} \]

Again the inequalities result from the early exercise premiums of the American options. Conversion and reverse conversion trading strategies in an efficiently operating capital market ensure that the relationship holds.

Futures option valuation. Under the assumption that futures prices are log-normally distributed, Black derived the valuation equation
for a European call option written on a futures contract. The valuation equation is
\[ c(F,T,X) = e^{-rT}[FN(d_1) - XN(d_2)] \]  
where \( d_1 = \left[ \ln\left(\frac{F}{X}\right) + 0.5\sigma^2 T\right]/\sigma\sqrt{T} \) and \( d_2 = d_1 - \sigma\sqrt{T} \). All other notation has been previously defined.

Again the formula has intuitive appeal. The term \( FN(d_1) \) is the expected terminal futures price conditional on the call option finishing in the money times the probability that the option will finish in the money, and \( XN(d_2) \) is the cost of exercising the option times the probability that the option will be exercised. In other words, the current value of the call is simply the present value of the amount that is expected when the call option expires.

The European put option written on a futures contract has the value
\[ p(F,T,X) = e^{-rT}[XN(-d_2) - FN(-d_1)] \]
where all notation is as it was defined for the call.

The American call option formulas are too cumbersome to be presented here, but a numerical example may prove illuminating.

<table>
<thead>
<tr>
<th>Stock Price</th>
<th>European Call</th>
<th>American Call</th>
<th>European Put</th>
<th>American Put</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>( c(S,T,X) )</td>
<td>( C(S,T,X) )</td>
<td>( p(S,T,X) )</td>
<td>( P(S,T,X) )</td>
</tr>
<tr>
<td>80.40</td>
<td>0.05</td>
<td>0.05</td>
<td>19.16</td>
<td>19.59</td>
</tr>
<tr>
<td>90.45</td>
<td>0.77</td>
<td>0.77</td>
<td>10.08</td>
<td>10.18</td>
</tr>
<tr>
<td>100.50</td>
<td>4.15</td>
<td>4.17</td>
<td>3.66</td>
<td>3.68</td>
</tr>
<tr>
<td>110.55</td>
<td>11.14</td>
<td>11.25</td>
<td>0.85</td>
<td>0.85</td>
</tr>
<tr>
<td>120.60</td>
<td>20.22</td>
<td>20.62</td>
<td>0.13</td>
<td>0.13</td>
</tr>
</tbody>
</table>

The values are based on the following parameters: \( X = 100, b = 0.02, r = 0.10, \sigma = 0.20, \) and \( T = 0.25 \)—the same as those used to price the asset options. As before, the American put is more valuable than the European put, because of its early exercise feature. But now the American call on a futures contract is more valuable than the corresponding European call, something not observed for asset options. This result is due to the daily settlement feature of futures contracts, which makes cash available when in-the-money futures options are exercised.

Empirical evidence. Since futures option markets are a relatively recent development, little empirical research on the pricing links such as (6) or (7) has been carried out, although some unpublished research on these links is under way.
Chin investigated the efficiency of the West German mark futures option market at the Chicago Mercantile Exchange, using weekly price observations for the period January 1984 through February 1985. Of the 532 arbitrage positions he constructed, only 13 were profitable before transaction costs. After transaction costs only 11 remained, roughly 2 percent of the sample. On the basis of this result, Chin concluded that the put-call parity price linkage is supported for the West German option.

Whaley used the American futures option valuation equations to identify mispriced S&P 500 futures options during the period January 1983 through December 1983. He demonstrated that the option pricing model is able to generate significant abnormal profits before transaction costs and, for out-of-the-money put options, after transaction costs. His evidence provides weak support of inefficiencies in this market.

Using the same methods, Stoll and Whaley examined the efficiency of the T-bond futures option market at the Chicago Board of Trade during the period October 1982 through December 1983. Before transaction costs trading profits did appear; after reasonable costs were imposed, however, the average profit was not significantly different from zero.

In summary, the results of the tests of futures option market efficiency are not as strong as they are for asset option market efficiency since one market—the S&P 500 futures option market—appeared to exhibit certain pricing inefficiencies. As market participants gain experience, however, one would expect these inefficiencies to disappear. Overall, the preliminary evidence of these studies indicates that arbitrage forces are active in establishing and maintaining the put-call parity pricing link as well as the valuation link.

**Asset Option–Futures Option Pricing Relations.** When the futures, futures options, and asset options expire at the same time, $T$, and have the same exercise price, the prices of European asset and futures options are equal (the horizontal line at the bottom of figure 4–5), that is,

$$c(F,T,X) = c(S,T,X)$$

and

$$p(F,T,X) = p(S,T,X)$$

The reasons for these equalities are that (1) the options are European and hence cannot be exercised before their expiration; and (2) the
value of the futures contract is equal to the value of the underlying asset when the contract expires. Since the payoff contingencies are the same as those posed by the asset options, they must have the same value.

The American options trading in the United States, however, do not share the same values. The American call option on a futures contract is worth at least as much as the American call option on the asset.

\[ C(F,T,X) \geq C(S,T,X) \]  
(8)

The American put option on a physical asset is worth at least as much as the American put option on the futures contract.

\[ P(S,T,X) \geq P(F,T,X) \]  
(9)

These results arise because, before expiration, the futures price exceeds the asset price. Therefore, the American call written on the futures contract has a higher value than the American call written on the asset, other factors remaining the same. Conversely, the American put option on the asset has a higher value than the American put option on the futures contract because the lower the value of the underlying instrument, the higher the value of the right to sell the underlying asset at the exercise price.

One asset on which both asset options and futures options are traded is the West German mark. The asset options trade on the Philadelphia Stock Exchange and the futures options on the Chicago Mercantile Exchange. Since the two options expire within a couple of days of each other, conditions (8) and (9) should hold in an approximate sense for these options. Chin investigated these relations, using weekly data for the period January 1984 through February 1985. Before transaction costs the call options violated (8) in 286 of 393 cases, and put options violated (9) in only 14 of 209 cases. After transaction costs, the number of violations were 21 and 3 for calls and puts, respectively. He concluded that the German mark option markets were efficient and the links, (8) and (9), reasonably tight once transaction costs were accounted for.

Summary and Conclusion. In this section, the pricing relations linking an underlying asset, futures on the asset, options on the asset, and options on the futures have been developed and empirically examined. The empirical evidence supports the hypothesis that these pricing links are reasonably tight—generally within the bounds of transaction costs. Because the markets appear to be closely linked,
the evidence indirectly supports the hypothesis that the option markets provide greater depth and liquidity in the underlying instrument's market and vice versa.

Success and Failure of the New Option Instruments

In this section the factors underlying the introduction, success, and failure of financial innovations are discussed, and some limited evidence on recent experience in the new options instruments is presented. We also consider policy issues related to the need for regulatory oversight of the introduction of new options instruments and the issue of contract proliferation.

Preconditions for Exchange-traded Options. The success of the new options instruments requires that certain preconditions that would apply equally well to other financial innovations, such as the new futures contracts, be met.

Uncertainty. Trading in options, like trading in futures, depends on the existence of uncertainty about the future value of the underlying instrument. Indeed, the basis for trading options is disagreement about the degree of uncertainty or the allocation of uncertainty among different market participants. Currency options, for example, would not exist if exchange rates were fixed. Similarly, options in agricultural commodities would not arise if government price support programs limited price variability.

Standardization. Exchange-traded options require standardized contracts, for without standardization secondary markets do not arise. An important role of exchanges and clearinghouses is to legitimate and guarantee standardized contracts so as to minimize the credit risk of dealing with a particular individual. In the view of Telser and Higinbotham, the creation of a standard contract that facilitates "trade among strangers" is the key reason for trading in futures contracts. In their view futures contracts provide an alternative, lower-cost means of trading the underlying asset.

Liquidity. Like futures contracts, exchange-traded options cannot succeed without sufficient interest on the part of users to ensure a liquid market. A liquid market is one in which a reasonable number of contracts can be traded without affecting the price. Liquidity thus requires sufficient competing investors, with no single investor having an overwhelming influence on the price either of the option or of the underlying asset. Liquid markets not only facilitate day-to-day
trading but also guard against the possibility that the price may be manipulated or that a short squeeze or corner may be engineered.

**Deliverability.** In the past deliverability was considered essential to futures and options contracts. Many of the new options and futures contracts do not call for delivery but instead call for cash settlement. Under cash settlement the individual exercising the option receives the difference between the exercise price and the current price of the underlying asset in cash instead of receiving the asset itself. Cash settlement is desirable because it eliminates delivery problems associated with acquiring the asset to make delivery. Cash settlement is problematic if the price of the asset is difficult to determine.

**Sophisticated financial markets.** The new option instruments demand a considerable degree of sophistication on the part of financial institutions, market professionals, individual investors, and other market participants because options instruments are complex and the factors determining options prices are more complicated and less familiar than those determining the prices of other financial instruments. The successful experience with options on common stocks and the growth of the financial services industry have undoubtedly helped to set the stage for the new option instruments.

**Options versus Futures.** The preconditions for options apply equally well to futures contracts. What explains why futures markets arise for some underlying assets, options markets for others, and both options and futures markets for still others? In a recent paper Jaffee suggests that futures markets will arise first for those commodities with particularly imperfect spot markets (for example, with respect to facilities for margin purchases and short sales), whereas option markets will first appear for those commodities that have relatively well functioning spot markets, but which require additional facilities for risk sharing and hedging. He cites as evidence for this suggestion the development of stock index futures before options on stock indexes, because of spot market problems of trading stock indexes, and the development of options on individual stocks rather than on futures because of the efficient spot markets for trading but not risk sharing of individual stocks.

This view is consistent with the Telser-Higinbotham justification of futures markets as an alternative means of trading the underlying asset. Options provide an additional benefit—a means of sharing
risk—that futures do not provide. Thus it would not be surprising to find both futures and options in underlying assets that have trading imperfections, which would include most commodities but also stock indexes and bonds. Stock indexes are not readily tradable, although mutual funds might approximate them. Most mutual funds are not traded in secondary markets, cannot be purchased on margin, and cannot readily be sold short. Similarly, many bonds are not traded actively in smaller amounts. One might thus expect both futures markets and option markets to arise in these markets. Since individual stocks are actively traded in an efficient market, however, an option market would seem to suffice, and futures on individual stocks would not be expected to arise.

**Elements of Contract Design.** A critical factor in the success or failure of the new options instruments is contract design. Optimal design in options, as in futures, necessitates that precise specification and standardization of the contract be balanced against its liquidity requirements. Precise specification can lead to a clearly but narrowly defined contract that is extremely useful to a few traders but of limited interest to the majority of traders. Such a contract may fail because of a lack of liquidity. A more broadly defined contract of some use to many market participants may succeed even though it is not ideal from the perspective of any participant.

**Number of contract series.** Any option on an underlying asset is a series of option contracts varying in expiration month and exercise price. The choice of these is an important element in contract design.

Too many expiration months detract from liquidity in any one month. Too few expiration months force certain traders to trade options of a maturity not suited to their needs. Thus the number of months chosen is restricted by the need to maintain liquidity in each of the months. The new options instruments rarely trade in more than three expiration months, and volume in the more distant months tends to be less than volume in the nearer months. As shown in table 4–2, most options written directly on stock indexes have a monthly cycle, that is, have contracts that expire in each of the next three months. Expiration months of options on futures tend to be determined by the futures maturity cycle, although trading is usually limited to the three nearest months.

Interest in options tends to be greatest when the striking price is at the price of the underlying asset. Consider a call option. If the striking price is too low, the option is in the money and begins to trade more like the underlying instrument and less like an option.
If the striking price is too high, the option is out of the money and has reduced price sensitivity. Exchanges therefore introduce option series the striking prices of which bracket the current market price of the underlying asset. Whenever the underlying asset price changes by a predetermined amount, a new option series is introduced. In the futures options on the S&P 500 stock index, for example, a new option series is introduced whenever the underlying index changes by five or more. In the futures options on T-bonds, new options are introduced whenever the underlying futures price changes by two or more.

The underlying asset. A key factor in the success of new options is the nature of the underlying item against which the option is written and the delivery terms associated with that item.

The strong similarities between an option on the physical asset and an option on the futures on the asset have been noted. Options on futures appear to have some practical advantages, however. First, many physicals make income payments or cause holding costs to be incurred that make pricing the option on the physical more complicated than pricing the option on a futures. In bonds, for example, accrued interest must be taken account of. In stock indexes dividend payments must be taken account of. Agricultural commodities incur storage costs that affect the price of the cash commodity. Options on futures are simpler because futures contracts make no payments and incur no costs of this kind. The futures price is based on the expectation of the price of the underlying asset after the period over which payments are made or costs incurred. In other words, futures contracts take account of income payments or storage costs so that options on futures need not.

Second, futures options simplify exercise of the option since the futures contract itself is delivered. Exercising an option on the physical may call either for delivery of the physical itself or for cash settlement. Delivery of the futures contract is frequently simpler, particularly since futures exchanges have tested methods for making such deliveries.

Third, futures contracts are themselves traded in exchange markets and thereby provide price information useful in pricing options. Prices are not so readily available for certain underlying assets. Prices for most debt instruments, which trade in over-the-counter markets, are difficult to determine. Prices of stock indexes are calculated from the prices of individual stocks at certain intervals and with some delay.

Another factor determining the success of an option, whether
written on the futures or directly on the physical, is the choice of underlying asset. A variety of debt instruments could serve as the underlying asset for a debt option. Similarly, a variety of stock indexes could serve as the underlying asset for a stock index option. Clearly, the recognition of and level of activity in the particular underlying asset are important. But beyond these a number of more complicated issues arise.

Several choices of debt instruments are possible: an index of debt instruments, a specific existing debt instrument, or a specific, yet-to-be-issued debt instrument. A debt index, like a stock index, would be a weighted combination, or a portfolio, of certain debt instruments. No options on debt indexes are now traded.

Options on specific government securities with broad markets are traded on the CBOE and the AMEX (options on T-bonds and on T-notes). These options are written on specific debt instruments existing at the time the option is originated, and they call for delivery of that instrument. Over the life of the option, the maturity of the underlying debt instrument declines, and this can affect the pricing of the option (beyond the complications associated with accounting for accrued interest).

Options on T-bond futures (on the CBT) are less complicated since they call for delivery of the futures contract if exercised. Options on T-bills (on the AMEX) are written on a yet-to-be-issued thirteen-week T-bill. If exercised, the option calls for delivery, on the Thursday of the week following the exercise, of a T-bill having thirteen weeks to maturity (which is generally the bill to be auctioned in the next week). Thus the instrument to be delivered is fixed in its characteristics (that is, maturity) but is not outstanding at the time the option is written. Arbitrage between the option and the underlying item is thus more complex and requires the use of the nearby T-bill.

Other factors in contract design. Several other factors are relevant in contract design. These include contract size, allowable price variation, position and exercise limits, trading hours, and margins. Of these, margins have received the most attention, in part because of the disparities in margin regulation of futures products and stock products. This issue is analyzed in greater detail later.

Competitive Factors. Another important element in the success or failure of particular options is the degree of competition among exchanges offering the same or similar options. As is evident in table 4–2, direct competition among two or more exchanges exists in options written on similar underlying assets. Physical options on stock indexes are offered by the CBOE, the NYSE, the AMEX, the Philadelphia
Stock Exchange, and the Pacific Coast Exchange; and physical options on Treasury securities are offered by the CBOE and the AMEX. Futures options on stock indexes are offered by the CME and the NYFE, and futures options on Treasury securities are offered by the CBT.

Given identically designed options instruments, two competitive factors are relevant to the success or failure of a particular exchange’s contract. These are (1) which exchange is first to market and (2) which exchange has the superior reputation.

First to market. Evidence suggests that trading in financial instruments is a natural monopoly, all other things being equal. In a natural monopoly the average cost of producing a product or service declines with the volume. A natural monopoly in the trading of a security arises because trading goes where trading is. Investors desire liquidity and will trade at the exchange that has existing volume. Thus the exchange that is first to market and generates initial volume is more likely to attract additional volume than an exchange that introduces a contract at a later date.44

The rush by exchanges to introduce new financial instruments and their concern about regulatory delay reflects their recognition of the importance of being first to market. To the extent that the exchanges are successful in bringing similar products to market at approximately the same time, the advantage of being first to market is eliminated. Success and failure then depend on other factors, such as contract design.

Exchange competence. The success of a contract also depends on the public’s view of the exchange’s competence. This depends on the exchange’s experience, financial integrity, and trading efficiency. Experience depends, among other things, on the number of years that an exchange has successfully offered contracts similar to the one being introduced. The financial integrity of an exchange is based on mechanisms that ensure the integrity of its members and on evidence of financial strength. Trading efficiency is derived from trading mechanisms that minimize the cost to investors of trading the instrument. Some exchanges use specialist-based trading systems; others use futures trading systems. The success of contracts depends in part on the efficiency of the trading system.45

Government Policy. Government regulatory policy has influenced the pace of financial innovation both broadly, by affecting the general economic conditions conducive to financial innovation, and narrowly, by affecting the success of particular new instruments.
Broad government policy. Broad government policy has affected the pace of financial innovation in at least two ways. First, the deregulation of financial markets, including such regulatory changes as lifting interest rate ceilings that apply to banks, lessening barriers to competition among financial institutions of all types, and deregulating the stock market, have reduced the profit margins of financial institutions and intensified the competition for customers. This situation, along with increased uncertainty in the economy and the increased sophistication of investors, has generated a demand for new financial instruments on the part of retail customers and a need on the part of many financial institutions for new tools for managing risk.

Second, government tax policy has influenced the development of new financial instruments. The taxation of futures contracts, in particular, has received significant attention in recent years. Trading in certain futures contracts was stimulated by their use as a means of postponing or avoiding taxes. For example, by setting up a spread—a long position in one contract month and a short position in another—traders created for themselves an option to realize the leg of the spread that generated a loss that could be used to reduce taxes. The tax treatment of futures contracts was modified by the Economic Recovery Tax Act of 1981 to require taxation of gains and losses whether realized or not. Such gains and losses on commodity futures positions are taxed at a maximum rate of 32 percent under current law (60 percent of any gain or loss is long term, taxed at a maximum of 20 percent; 40 percent is short-term gain, taxed at a maximum rate of 50 percent). The 1984 tax bill accords options on instruments other than individual stocks or narrow-based stock indexes the same tax treatment as futures contracts.

A significant number of complications and unresolved issues remain with respect to the taxation of options and futures. These are beyond the scope of this chapter. Suffice it to say that the growth of trading in particular options instruments will be influenced by their tax treatment. To the extent, for example, that a position using options permits an investor to replicate a position in an underlying instrument at a lower tax obligation, trading in such options will be stimulated. Hamada and Scholes discuss some instances of tax arbitrage that can benefit certain kinds of investors.46

Specific regulatory policy. Specific regulatory policies of the SEC and the CFTC affect the success of new option instruments. Options on futures can be purchased only in a commodity account from an account executive qualified to trade commodities, and options on
physicals are purchased in a securities account from account exec­
utives qualified in options. Since securities accounts outnumber
commodity accounts, options on futures contracts are at a marketing
disadvantage with respect to options on physicals. Individual inves­
tors may be reluctant to set up a commodity account and may choose
simply to trade those options eligible for trading in a securities account.

A number of other regulatory disparities can affect the success
of options on futures vis-à-vis options on physicals. Disclosure
requirements and surveillance procedures, for example, differ between
futures and physicals. Margin regulations also differ. In particular,
the cost of margining securities products appears to be higher than
the cost of margining futures products. This issue is discussed in
greater detail later in this chapter.

Evidence. Evidence on the relative success of the various new options
instruments is presented in table 4–4, in which option contracts are
ranked by open interest on July 26, 1984, within four major cate­
gories—options on stock indexes, on debt instruments, on curren­
cies, and on commodity futures. Corresponding volume data for the
week ending July 27, 1984, are also presented. (Ranking contracts
by volume instead of open interest would have produced nearly the
same ranking.) Several conclusions emerge from this evidence,
although a more complete history and a more careful analysis will
be required to reach definitive conclusions.

• The broad stock indexes have been extremely successful as a
group. The top five options accounted for put and call contracts on
over $13 billion of the underlying assets on July 26, 1984.
• The narrow stock indexes have generated much less interest.
The five most successful narrow-based indexes had a total open
interest of about $250 million, less than 2 percent of the total open
interest of the top five broad stock indexes. Several contracts have
been delisted.
• The competitive success of different contracts is not yet wholly
clear. The options on the S&P 100 (CBOE) are by far the most active
of the broad index options, followed by the CME futures options on
the S&P 500. Some factors contributing to the success of this contract
are that it was nearly first to market (second to the S&P 500 futures
options), that it was introduced by an exchange with experience in
option trading, and that it benefits from the existence of futures on
the same underlying index, something that is helpful in pricing the
option. The greater success of the CBOE S&P 100 option than of
the CME S&P 500 futures options may also be due to the larger
### TABLE 4-4

**Dollar Open Interest and Dollar Volume of Trading for Options Ranked by Dollar Value of Open Interest on July 26, 1984**

<table>
<thead>
<tr>
<th>Underlying Instrument (Exchange)</th>
<th>Open Interest ($ million)</th>
<th>Volume Week Ending July 27, 1984 ($ million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Options on stock indexes and stock index futures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S&amp;P 100 (CBOE)</td>
<td>10,097</td>
<td>16,290</td>
</tr>
<tr>
<td>S&amp;P 500 futures (CME)</td>
<td>1,820</td>
<td>854</td>
</tr>
<tr>
<td>NYSE composite (NYSE)</td>
<td>1,018</td>
<td>497</td>
</tr>
<tr>
<td>Major market (AMEX)</td>
<td>646</td>
<td>230</td>
</tr>
<tr>
<td>NYSE composite futures (NYFE)</td>
<td>250</td>
<td>148</td>
</tr>
<tr>
<td>Computer technology (AMEX)</td>
<td>116</td>
<td>161</td>
</tr>
<tr>
<td>Oil and gas (AMEX)</td>
<td>69</td>
<td>17</td>
</tr>
<tr>
<td>Market value (AMEX)</td>
<td>62</td>
<td>52</td>
</tr>
<tr>
<td>Gold/silver (Philadelphia)</td>
<td>55</td>
<td>25</td>
</tr>
<tr>
<td>Transportation (AMEX)</td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td>S&amp;P 500 (CBOE)</td>
<td>3</td>
<td>0.5</td>
</tr>
<tr>
<td>Gaming/hotel (Philadelphia)</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>Technology (Pacific)</td>
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<td>a</td>
</tr>
<tr>
<td>Transportation (CBOE)</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>Value Line index (KCBT)</td>
<td>Delisted</td>
<td></td>
</tr>
<tr>
<td>S&amp;P international oils (CBOE)</td>
<td>Delisted</td>
<td></td>
</tr>
<tr>
<td>Computer and business equipment (CBOE)</td>
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<tr>
<td>Telephone (CBOE)</td>
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<tr>
<td>Options on debt instruments and debt instrument futures</td>
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<td>T-bond futures (CBT)</td>
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<td>T-bonds (CBOE)</td>
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<td>T-bills (AMEX)</td>
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<td>British pound (Philadelphia)</td>
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<td>Japanese yen (Philadelphia)</td>
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<td>West German mark futures (CME)</td>
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<td>Options on commodity futures</td>
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<tr>
<td>Gold (COMEX)</td>
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<td>953</td>
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<tr>
<td>Sugar</td>
<td>18</td>
<td>182</td>
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**Notes:** Dollar open interest is the sum of put open interest and call open interest times the dollar value of the contract. Dollar volume is the put and call contract volume times the contract value. For abbreviations of exchange names, see table 4-2.

a. Data not available in the Wall Street Journal. Presumed to be small.

b. Only the total number of contracts in all Philadelphia currencies was available. Dollar figures based on a dollar contract size of $22,000 in each currency. Dollar contract size ranged from approximately $17,500 for the British pound to approximately $38,500 for the Canadian dollar.

**Source:** Wall Street Journal.
number of investors trading CBOE stock options in securities accounts and the lack of familiarity of futures market traders with the stock market. Some of the other broad index options appear to be sufficiently profitable to continue their operation. The option on the NYSE composite index benefits from the strength of the NYSE as an institution and the existence of a futures on the same index. The failure of the option written directly on the S&P 500 is somewhat surprising in view of the success of the option on the S&P 100 and the fact that the S&P 500 is much more widely known. The failure of the option on the Value Line futures index on the KCBT reflects the low volume of the underlying futures, the secondary status of the exchange, and the problematical characteristics of the Value Line index.  

- Among the debt options only the option on the T-bond futures is a clear success. Unlike the most active stock index options, this is an option on a futures contract, which has a number of benefits (pricing information is readily available; arbitrage and delivery are simpler). Options written directly on debt instruments do not appear to have generated much demand.
- Options on currencies and on currency futures, though not generating the level of activity of some of the options on stock indexes, appear to be successful. The relative advantages of options on futures (the German mark on the CME) and options directly on the currency (the Philadelphia currency options) have yet to be fully tested.
- Only two options on commodity futures had traded at the time these data were compiled. The gold options had had some success, but the sugar options had attracted very little interest.

**Competitio, Regulation, and the Option Approval Process.** The pace at which new futures and options contracts are being introduced to the financial markets has confused the public and overwhelmed even expert market observers. Cries for a more orderly introduction of new instruments have arisen from various sources, including legislators, regulators, and the industry. The costs and benefits of moderating the pace of financial innovation are considered here.

A characteristic of an innovating industry is a state of confusion in the early stages of development as many firms rush to be first to market. Frequently an incomprehensible array of products, not all of which function properly and some of which are poorly designed, are brought onto the market. Consumers are confused, and prices are highly variable. These characteristics describe the introduction not only of new financial instruments but also of new products in other industries, such as the personal computer industry in the 1980s or the automobile industry in the 1920s. A shakeout phase and a
period of confusion are typical of new industries. Usually competitive forces are left to determine which producers and which products survive.

Our analysis of success and failure has already shown that this competitive process is rationalizing the market for new options instruments. Relatively few contracts are outstandingly successful. Many have been failures, including most of the narrow stock indexes and options written directly on Treasury securities. In fact, there may be little need for regulatory oversight of the innovation process since the competitive process appears to be a relatively quick and effective means of disciplining exchanges.

Financial instruments do differ from other products, however, in that certain external effects may be associated with the introduction of similar competing financial products by different exchanges. As Silber has noted, competition among exchanges in the same instrument fragments trading and reduces the liquidity in each market. This is undesirable since the efficiency of a market is related to its volume of trading. No exchange introducing a new product will take account of this external effect, although exchanges acting as a group or acting through regulators might well agree to share markets in some way so as to avoid fragmentation. An argument, therefore, for regulation of the innovation process and contract review is that they are needed to guard against fragmentation of markets.

There are two counterarguments to this position, as Silber has also noted. First, fragmentation of financial markets is less serious than it may at first appear since an arbitrage mechanism connects the various markets. Market professionals have memberships on a variety of exchanges and are in a position to arbitrage price discrepancies. As long as prices in one market are kept from deviating from prices in another, various physically separate markets behave, from the perspective of pricing, as if they were one market. The ease of such arbitrage, of course, depends on the transaction costs and communication costs associated with accomplishing it, and regulators should be concerned that no artificial barriers are imposed on arbitrage. A second counterargument is that limiting fragmentation by limiting the introduction of competing instruments limits competition and favors one exchange over another. Restricting competition also limits the innovation process.

The CFTC options pilot program limits the pace of financial innovation, and the desirability of restricting the number of options that each exchange may trade may be questioned. Regulatory oversight may be desirable from the perspective of customer protection and maintenance of the integrity of financial markets, so that regu-
lators may gain experience with new products and so that financial markets may assimilate new products in an orderly fashion. The pilot program can be broadened, however, to allow the introduction of more products while still permitting the CFTC to maintain the necessary oversight and gain the necessary experience. This broadening of allowable products is particularly justified if additional products of a similar kind are to be offered for which regulatory analysis has already been performed.

Margin Requirements

The advent of related financial instruments under the jurisdiction of different regulatory agencies raises issues of regulatory disparity. One of the most important of these is the issue of margin requirements. Under the Securities Act of 1934, the SEC has the authority to oversee exchange rules including margin rules, and the Federal Reserve has the authority to set initial margins on equities and other "securities." The Federal Reserve has for a long time regulated margins on equity securities but did not establish margins on securities options until 1977, when it issued margin requirements that mirrored industry practice. Margins on futures contracts and on options on futures contracts are set by individual futures exchanges and have not been subject to the jurisdiction of the CFTC or the Federal Reserve. In this section we review the rationale for regulatory authority over margins as applied to options, the factors relevant to setting margins on options contracts, and alternative margin systems for options. Some of these same topics are discussed in recent papers by Figlewski and by Phillips and Tosini.

Margins on Stocks versus Margins on Futures versus Margins on Options. Margins on options and futures should be distinguished from margins on common stocks. The margin on a common stock constitutes the percentage of the total purchase price paid by the investor. The remainder is borrowed. Currently, the initial margin on common stocks, set by the Federal Reserve, is 50 percent, and the maintenance margin, set by the individual exchange, is 30 percent. Margins on common stocks control the amount of credit that various lenders may extend for the purchase of stocks. The desire to control the extension of credit was a reason for establishing margin requirements on stocks.

Margins on futures contracts constitute a guarantee of performance of a contractual obligation. When a futures contract is entered into, no credit is extended, no asset changes hands, and no payment
is made by the buyer to the seller. Only if delivery is made is full payment (part of which could be borrowed) required. Both the buyer and the seller of a futures contract deposit margin, which may frequently be in the form of interest-earning assets rather than cash. Positions in futures contracts are marked to market daily as the futures price changes. Investors are required to make up any losses or to withdraw any profits. These payments from losers to gainers, called "variation margin," must be in cash.

Options have some features of common stocks and some features of futures contracts. As in common stocks, a payment is made when the option contract is entered into. The buyer of an option pays a premium for an insurance service rendered by the seller of an option. The buyer of a call option, for example, has a right to purchase the underlying asset at a known exercise price and is insured against any losses if the underlying asset price falls below the exercise price. Although no asset changes hands when an option contract is entered into, payment for the "insurance service" is made, and money changes hands. Under current margin procedures for futures options as well as securities options, the buyer of a put or call pays 100 percent of the premium. Suggestions have been made, however, that premiums on futures options be marginable. Sellers of options have contractual obligations, and margins on sellers are performance guarantees in the same way as margins on futures contracts. The clearinghouse that guarantees the performance of the seller must be assured that the seller can carry out his obligation, and it requires margin at least as great as the current market value of the seller's obligation. In the subsequent discussion, margins are viewed as a performance guarantee, not as a method for regulating credit.

Current Margins on Options. Appendix A lists customer margin requirements on naked long or short positions in put and call option contracts representative of margin requirements established by the different futures exchanges and stock exchanges. In all cases—whether individual common stocks or futures contracts—the buyer of options (the long) pays 100 percent of the premium.

Substantial differences arise in the margining of the seller's position (the short position). Options on common stocks and narrow-based indexes have margins based on the cost of acquiring the underlying instrument for delivery, whereas margins on other options are premium based. The writer of a call option on an individual stock is required to post 30 percent of the value of the stock—the stock exchange's maintenance margin on long stock positions. This is the minimum margin required as collateral on a loan to purchase common
stocks, and it is in this sense that margins on stock options are security based. As Figlewski has pointed out, this can lead to substantial overmargining.

Margins on other options are premium based in the sense that the investor is required to post as margin the premium plus a "cushion." A premium-based margining system assumes that the option seller's obligations may be met by covering his short position, not necessarily by delivering the underlying asset. As long as the seller posts sufficient funds to cover the short position, which would require the outlay of the current premium, the obligation is met. Premium-based systems thus require the premium to be marked to market and a cushion to protect the broker during the period in which the margin call is made.

**Rationale for Margin Regulation.** The rationale for officially regulating margin requirements is conditioned by their purpose. Margin regulations may be viewed as protection for the customer or as protection for the financial system.

*Protection for customers.* The rationale for margin as a protection for customers hinges on the idea that investors must be protected from excessive speculation. Setting margin requirements sufficiently high makes speculation costly and thereby reduces it. This rationale played an important role in the 1930s legislation that gave the Federal Reserve authority to set initial margins on common stocks.

The efficacy of margin requirements in limiting speculative excesses in the stock market is subject to considerable dispute. First, there is evidence that securities markets are efficient in the sense that prices reflect underlying values. Indeed, excessive margin requirements may limit the supply of risk capital that maintains market efficiency and contributes to market liquidity. Second, empirical evidence on margin requirements in the stock market suggests that margin requirements have little effect on stock prices. Margin requirements may be ineffective because the bulk of investors behave in the same way regardless of the margin requirements or because margin requirements may be evaded by using other assets as collateral for borrowing.

The dispute arises because proponents of margin regulation question the efficiency of the stock market and the limited effect ascribed to margin regulations. Furthermore, their concern is with respect to small, unsophisticated investors who are drawn unknowingly into a playing arena with which they are unfamiliar. Margin requirements are needed to protect these unsophisticated investors.
from committing excessive capital to the stock market or the futures markets. At issue then is what Figlewski calls "investor sovereignty"—whether individual investors will be allowed to make their own mistakes or will be inhibited in their investment decisions by margin requirements set for them by a regulatory authority.  

Protection for the financial system. A second rationale for margins is the protection of the financial system. Brokers, dealers, and other financial institutions are linked with one another and with their customers by a variety of financial obligations. Loss of confidence in a particular broker can produce a run on that broker and place strains on the entire financial system. Margin requirements are thus necessary to protect the financial integrity of individual brokers and thereby the entire financial system.

This rationale for regulating margins has been questioned, however. It is in the interest of each brokerage firm to protect itself against bankruptcy and to ensure that its customers can meet their obligations. Furthermore, it is in the interest of exchanges to ensure the financial integrity of their members, since the desirability of trading on an exchange depends in part on its financial strength. Exchanges establish minimum margin requirements for their members and customers of their members whether or not such requirements are mandated by regulatory authorities. Moreover, exchanges typically maintain a guarantee fund to support any member firms that are in danger of failing.

Only when regulatory authorities provide insurance, as through the Securities Investor Protection Corporation (SIPC) in the securities industry, is the rationale for the regulatory establishment of margins clearer. For then the ultimate guarantor of firms is the government, and the government must protect its guarantee fund in the same way that any exchange would wish to protect itself. This rationale for margin setting applies to options on common stocks and on indexes purchased in securities accounts eligible for SIPC protection. It does not apply to futures contracts or options on futures, which are not eligible for SIPC protection. This rationale does not necessarily imply that government margin on options in securities accounts insured by SIPC would be different from margins on options in futures accounts not insured by SIPC but guaranteed by an exchange. Nor does it imply that margins are necessarily the optimal method of protecting the government insurance fund. Other methods, such as reserves, segregation of funds, and capital requirements, may be more effective.
Factors Affecting the Appropriate Margins on Options and Futures.

Setting margins on options and futures, whether from the perspective of a regulator, an exchange, or an individual firm, is a complex process. The optimal margin depends on characteristics of the customer, characteristics of the security, characteristics of the market, and characteristics of the transaction.

Characteristics of the customer. Margins are a guarantee that the customer will adhere to the contract. The need for such a guarantee, therefore, depends on the customer's ability and willingness to honor the contract. Among other things, these depend on the customer's honesty and integrity and on total wealth. An individual who is known to the broker and who has substantial wealth invested in a well-diversified portfolio would generally be able to post lower margin than a new customer with uncertain wealth. In practice, minimum margins set by exchanges or regulatory bodies cannot take account of investors' characteristics.

Characteristics of the item. Margin is intended to protect the broker during the period required to collect funds or issue a margin call. Margin on individual options or futures contracts should provide sufficient protection against short-term price volatility over the period required to collect additional funds from the customers. Highly volatile options or futures contracts would therefore require greater margin than stable futures contracts or options. Since volatility changes over time, margins should also be changed.

Characteristics of the market. Optimal margins depend on the characteristics of the market. A market with price limits, for example, may inhibit excessive price moves and give time to reconsider and collect additional margin. In such a market the financial integrity of brokers and dealers may be ensured with lower margin requirements. Margins are also required to protect brokers and dealers during the period in which settlement of transactions is completed. In the stock options market, for example, the settlement period is five business days. In principle, customers' deposits and margin requirements ought to be greater in this market than in a market in which settlement takes only one day. Other characteristics of a market, such as its liquidity, which affects the speed with which a customer's position can be liquidated, should also influence the margin.59

Characteristics of the transaction. Most options and futures contract transactions are not conducted in isolation. Investors hold other assets. To the extent that the option's or futures contract's price movements
are less than perfectly positively correlated with the price movements of the remainder of an investor’s portfolio, the risk to the investor and to his broker is reduced, and hence the margin requirement should be lowered. Exchanges recognize the importance of considering the purpose of a transaction by setting different margin requirements for spreads or hedges than for naked positions in options or futures.

Current margin systems seem to generate the greatest inconsistencies in their attempt to take account of the characteristics of the transaction, that is, the extent to which a particular transaction is a spread or hedge that actually reduces risk. Current practice uses a pairing procedure to adjust margins in an option position when positions in related options or in the underlying item are held by the investor. The margin for the seller of a call, for example, is reduced or eliminated if the seller buys a call or holds the underlying instrument. Some examples of margin requirements on spread positions involving options and futures are contained in appendix B.

Margining systems that use a pairing procedure are, however, cumbersome and frequently inaccurate. An investor with a large number of options positions would, under this procedure, be required to pair various options in some optimal manner to determine the margin obligation. As Figlewski points out, algorithms to do this can give substantially different results. Furthermore, many pairings are not permitted for margin purposes, with the result that margins are too high. Although margin adjustments are made for vertical spreads in options (long call, short call or long put, short put), only one-for-one pairings of a long and short option are considered. A short position in an at-the-money option cannot be paired against a long position in two out-of-the-money options.

A second difficulty of current margin systems is that option payoffs are nonlinear with respect to the price of an underlying item with which an option may be paired, a condition that is not always properly reflected in the margin system. A deep in-the-money call, for example, will have absolute price changes much like the underlying item, while an out-of-the-money call will experience price changes much smaller than those of the underlying item. Current margining systems do not properly take account of the different volatilities of these two kinds of options or of the risk reduction possible by pairing the options with the underlying item. This problem has given rise to proposals for “delta” margining systems, which take explicit account of the volatility of options in relation to underlying items.

The delta of an option is the price change in the option associated with a one-dollar price change of the underlying item. Thus a short
position in two call options each with a delta of $-\frac{1}{2}$ paired with a long position in the underlying item is not a very risky position, since a one-dollar decline in the value of the call options position will tend to be offset by a one-dollar increase in the value of the long position in the underlying item—the delta of the total position is zero. Under a delta margining system, margin for such a position would be much less, for example, than for the position long one in-the-money call with delta of $\frac{3}{4}$ and short one out-of-the-money call with delta of $-\frac{1}{4}$. This position has an overall delta of $\frac{1}{2}(\frac{3}{4} - \frac{1}{4})$, which would require margin approximately one-half that required for the underlying item.

**Optimal Margins.** The purpose of any margining system is to ensure that investors have sufficient equity to meet their obligations, even in the presence of unexpected events that would lower the value of their equity. Equity is the market value of all the investor's assets (including long options) less the market value of all the liabilities. Thus "margin" and "equity" are synonymous. The purpose of a margin requirement is to ensure a current equity, $V_0$, such that

$$\text{Prob}(\hat{V}_t > 0 | V_0) \equiv \alpha^*$$

where $\hat{V}_t$ = the uncertain future value of the investor's equity in $t$ days, where $t$ is the number of days required to issue a margin call and collect funds or sell assets, $V_0$ = current market value of the investor's equity, and $\alpha^*$ = a critical probability. In words, the equation says that the investor's equity must remain positive with a probability that exceeds a critical level. Condition 10 can, of course, be modified to require equity to exceed any number greater than zero with the same critical probability. Whether this condition will be met depends on the variability of investors' portfolios and the time period $t$. The variability of the portfolio depends on its composition. For example, a portfolio of fully paid for T-bills can easily meet the condition. A portfolio of one T-bill and fifty futures contracts may not meet the condition. If not, either more T-bills must be supplied, or the number of futures contracts must be reduced.

Assuming $\hat{V}_t$ is normally distributed, condition 10 is equivalent to

$$V_0 - k\sigma(\hat{V}_t) \geq 0$$

where $k$ = number of standard deviations below $V_0$ that corresponds to $\alpha^*$. The minimum equity, or margin, required is thus given as

$$V_0^* = k\sigma(\hat{V}_t)$$
In figure 4–7, the distribution of $\bar{V}$, given by portfolio A is undermargined since the probability of values below zero exceeds an acceptable level. The distribution of portfolio B is sufficiently margined since there is virtually no probability that the equity value will fall below zero.

The approach outlined here for setting margins can be applied to various portfolios, as is done in appendix C. Appendix C shows that when financial instruments are considered in isolation, the total margin is considerably greater than when the margin on the portfolio as a whole is calculated, because the diversification of the portfolio reduces risk and therefore reduces the required margin. The margin requirements from this perspective are quite different from those that would be calculated in a security-by-security margining system. Failure to consider the entire portfolio of the investor introduces the same margins on a particular transaction for investors with widely different risk positions. Under the current regulatory structure, which requires separate customer accounts for commodities instruments and stock instruments, a margining system of this kind is difficult to implement in practice. In addition, when investors choose to maintain a variety of separate accounts, it is virtually impossible and inappropriate. It is feasible, however, to consider each investor's account as the portfolio that is to be margined in this manner.

**Margining the Option Premium.** Unlike a futures contract, a call or put option has a positive market value when purchased. The premium paid is the initial value of the option; if the price of the underlying asset moves in a favorable direction, the market value of the option
increases. Such increases in value can be realized, however, only by selling or exercising the option. A futures contract, has no initial value. It has value only if the futures price changes favorably with respect to the contractual futures price initially agreed to. Profits on such price increases are realized daily without liquidating the position.

These features of options result in certain asymmetries first noted by Asay. Increases in option values require additional collateral to be deposited by option sellers but do not permit withdrawal of profits by option buyers. Thus someone with a synthetic long position in the futures contract (buy call, write put) hedged against a short futures position would, if prices increased, be required to make cash payments to cover losses on the short futures position but would not have cash profits on the synthetic long position. This feature inhibits arbitrage between options and futures. Current arrangements also provide an incentive for early exercise of in-the-money options, because interest may be earned on the exercisable proceeds of the option. This early exercise feature complicates option pricing as well as arbitrage between options and futures.

In response to suggestions by futures exchanges, the CFTC has proposed a futures-style margining system for options. Under such an arrangement the buyer of an option would agree to pay the option premium when the option is exercised. The performance of this agreement would be guaranteed by appropriate performance margins, as in the case of futures. The seller of the option would likewise post performance margin (greater than that of the buyer since the seller's obligation is greater). If the market price of the option declined, the buyer would pay the losses in cash to the clearinghouse, and the seller would collect profits from the clearinghouse.

This proposal is somewhat different from a situation that would allow borrowing against the value of the option, as in a stock-style margining system. In effect, a futures-style margining system redefines the option contract to call for payment of the premium at a future date, whereas a stock-style margining system would retain the existing definition of an option contract but would simply allow an option to serve as collateral for borrowing. The CFTC has favored a futures-style margining system because such a system is more compatible with existing procedures on futures exchanges.

The benefits of a futures-style margining system for options on futures contracts arise from the elimination of asymmetries in cash flows between options and futures. Arbitrage would be better facilitated, and option pricing would be simplified. Opposition to such a system arises from a desire to protect customers and the financial
system. Since options premiums constitute only a fraction of the value of the underlying asset, margining of the premium appears to be a pyramiding of financial obligations. There is concern that customers do not fully understand the risks of posting only a fraction of the premium and that the stability of the financial system might also be impaired. Apparently for this reason, the CFTC proposal calls for customers to pay 100 percent of the premium and would allow only exchange members the freedom to use a futures-style margining system.

This distinction between public customers and exchange members is unfortunate. It is not evident that public customers are necessarily less sophisticated than members. Most important, however, this distinction introduces a number of difficulties. One of these is a practical one of setting up computer margining systems that differentiate between members and nonmembers. Second is that such a system appears to generate free cash for members at the expense of public customers. If the public pays 100 percent of the option premium in cash and a member need only pay a performance guarantee, members receive cash deposits from customers. Furthermore, the pricing of options from the perspective of customers is different from the pricing of options from the perspective of members. Clearly, this is unacceptable. A futures-style margining system should apply equally to members and nonmembers. Concerns about protection of customers can be met by requiring a sufficiently large performance guarantee. This is not burdensome, even if the guarantee is 100 percent of the option premium, as long as the margin pledged is in the form of interest-earning assets. The key benefit of a futures-style margining system is that cash is not paid at the outset. The adoption of such a margining system would put options and futures on the same footing and simplify pricing relations between them.

How Costly Are Margin Requirements? We have viewed margin as the investor’s equity and optimal margins as the amount of equity sufficiently large in relation to liabilities that positive equity would remain even in the face of large, unexpected price changes. No requirement was established that optimal margin be supplied in any particular form such as cash, only that margin be sufficiently large, in light of all the potential price changes of the assets and liabilities in an investor’s portfolio, to guard against his bankruptcy. Margin requirements are costly if an investor is compelled to hold equity in a particular form, such as cash. Cash margin requirements force the investor to forgo the interest earnings on the cash. One of the characteristics of existing stock-margining systems is that they sometimes
impose costs of this kind on the investor. The margining cost of selling an individual stock short is substantial and has been an impetus for trading in options and in stock index futures.

Futures contracts margin can usually be pledged in the form of U.S. Treasury securities. Even though this appears to be restrictive, investors can usually modify the rest of their portfolio to account for this fact and still achieve an optimal overall portfolio.

Brokers naturally have an interest in requiring cash margin deposits from their customers. But this is difficult in a competitive system because customers choose brokers that allow margin to be pledged in the form of interest-earning assets or that pay interest on margin deposits. Only the brokerage industry as a whole could effectively impose cash margin requirements, especially if regulatory authorities mandated such deposits.

Thus an important issue for regulatory authorities, beyond the issue of setting mandatory margins, is the form in which these margins may be pledged. If they may be pledged as interest-bearing assets, the cost of a mandatory margin system is small, and the arguments against regulating margins are less forceful. Issues of regulatory disparity in the setting of margins for stock products and futures products are also muted. But if margin must be pledged in the form of cash, the cost is high, and arguments against mandating such margins are strengthened. Issues of regulatory disparity also become more forceful and must be dealt with in a "fair" way.

Regulating Margins. In determining whether, and to what degree, margins on various financial instruments, including options, should be set by regulatory authorities, several factors must be considered.

• the need for customer protection and maintenance of the integrity of the financial system
• whether government authorities insure brokers
• the extent to which, under a nonregulated margining system, brokers would have an incentive to protect the integrity of the financial system
• the complexity of margining systems
• the cost of margins

In our view brokerage firms and exchanges have strong incentives to set appropriate margins that protect the integrity of the financial system and thereby protect customers. Indeed, this is one of the ways in which exchanges compete. When governmental authorities insure customers' deposits at brokerage firms, that incentive is mitigated to some degree, and an argument for governmental
oversight of the financial integrity of individual brokerage firms is justified. Only securities accounts are now insured by the SIPC, and margin regulations are thus more readily justified for stock products than for futures products. But even for stock products other forms of maintaining the integrity of brokerage firms exist, particularly net capital requirements, segregation requirements, and reserve requirements.

The process of setting margins is highly complex, particularly for the new options instruments and for futures products. Appropriate margins depend on characteristics of the customer, characteristics of the security being margined, characteristics of the market, and characteristics of the portfolio of the investor and of the particular transaction (whether speculative or hedged). These complexities, as well as the fact that appropriate margins change over time, would make the setting of detailed margin requirements a regulatory nightmare. It appears to be appropriate, however, for regulatory authorities to oversee the establishment of general margining systems, without specifying detailed margin requirements. Such oversight would also ensure that margining systems did not benefit brokerage firms at the expense of their customers (for example, by imposing cash margin requirements). In our view the recent recommendation of the Federal Reserve that specific federal margin regulations be repealed and the authority to set margins be assigned to various self-regulatory organizations, under general government oversight, is sensible.64

Summary and Conclusions

Options on instruments other than common stocks are the most recent of a series of financial innovations introduced by futures exchanges and stock exchanges. Options on U.S. government debt instruments began trading in October 1982; since then options on stock indexes, options on currencies, and options on particular commodities have begun to trade. These new option markets are the focus of this chapter.

The chapter begins with an introduction to options and to the new option instruments: describing the new options and distinguishing among options on physicals, options on futures, and over-the-counter options. The procedures for trading the new option instruments are explained. Options on all exchanges are issued and guaranteed by a clearinghouse, much as futures contracts are originated, but the trading mechanisms vary. Options on futures exchanges are traded like futures contracts, and options on stock exchanges are traded like common stocks. The advantage of a futures market is the
high degree of competition on the floor, but a disadvantage is the lack of continuous price reporting and fully effective time and price priority rules. The advantage of a stock exchange trading system is the existence of effective price reporting and rules for time and price priorities, but a disadvantage is the lack of competition among traders on the floor.

The new options are regulated both by the SEC and by the CFTC. The CFTC has regulatory jurisdiction over options on futures contracts, and the SEC has regulatory jurisdiction over options written directly on debt instruments, stock indexes, and currencies.

We then discuss the economic benefits of options in some detail. Options are a unique hedging tool because they provide hedges that are not available with the use of futures contracts. Options are also a useful investment tool because they provide a means of increasing or limiting the risk of a portfolio that is not available with the use of other financial instruments. The social benefits of options arise from their ability to allocate risk more efficiently than other financial instruments and from their role in increasing the interest and the number of judgments bearing on the price of the underlying asset. Social concern about options arises from the belief that they are merely a form of gambling and have no fundamental economic purpose. Other sources of concern are that options trading can be abused to benefit professional traders at the expense of unsophisticated traders and that certain undesirable external effects on the underlying asset arise from the existence of options trading. These criticisms of options trading merit attention, but they are not, in our view, sufficiently forceful to warrant limiting the new options markets. The new instruments have important economic uses, and they do not adversely affect the markets in the existing instruments.

The link among option prices, futures prices, and the underlying asset prices are discussed. We show how the price of an option is related to the price of the underlying asset and to prices of related options. The put-call parity relation that links put and call options to each other and to the underlying item is developed, and the distinction between put-call parity for options on physicals and options on futures is drawn. Valuation equations for options on physicals and on futures show how the value of an option depends on the volatility of the underlying instrument and certain other factors. Arbitrage links the prices of related financial instruments and causes price changes in one market or one instrument to be transmitted to other markets or instruments.

Empirical evidence on the efficiency of the new options markets—or the "tightness" of price links—is summarized. The T-bond futures
options market appears to be efficient after transaction costs are accounted for. The S&P futures options market exhibits some inefficiencies, but these appear to be related to the lower trading volume in that market and the fact that observed prices may not be prices at which arbitrage transactions can take place.

We next examine the roles of contract design, interexchange competition, and government policy in influencing the success or failure of the new options instruments. The market mechanism appears to discipline undue contract proliferation effectively. Evidence on open interest and volume indicates that many of the new option contracts have not been successful. Only certain options on broad stock indexes and the T-bond futures options have been clearly successful. Regulatory limit on the introduction of new financial instruments may be counterproductive insofar as they limit competition among exchanges, favor one exchange over another, and limit financial innovation itself.

Finally we examine margin requirements. An important regulatory disparity arises from the fact that margins on equities and other securities are set by the Federal Reserve and the SEC whereas margins on futures contracts and options on futures contracts are set by individual futures exchanges and are not subject to governmental regulation. The desirability of regulating margin requirements has been much discussed. On the one hand, brokers and exchanges have incentives to set margins that protect brokers and thereby customers and the financial system against the failure of any brokerage firm. Furthermore, the setting of margins is inherently complex, particularly with respect to positions in options and futures, and does not lend itself readily to detailed regulation. On the other hand, when government agencies insure customer deposits, some government involvement in the setting of margins is justified. The cost of margin requirements to the investor is not high if margin may be pledged in the form of interest-earning assets. In that case, governmental setting of margin requirements, even if somewhat arbitrary, does not impose a great burden on individual investors. Recent proposals to permit the margining of the option premium have merit, but the recent CFTC proposal to draw a distinction between brokers and customers has some unfortunate consequences.

Economists have long recognized the benefits of trading in contingent claims. A contingent claim is a contract that gives the individual a payoff contingent on a particular outcome for some underlying event or asset. The existence of markets in contingent claims permits individuals to plan their investment and consumption...
for future periods more effectively. Although markets are not complete in the sense of allowing individuals to plan for any contingency, the advent of the new options markets and the introduction of options on particular commodities broaden markets in a way that allows individuals to deal more effectively with economic uncertainty.

Appendix A

Margin Requirements on Naked Options

1. Options on common stocks
   Long put or call: 100 percent
   Short put or call: 30 percent of value of underlying stock plus in-the-money amount or minus out-of-the-money amount; minimum of $250 per contract

2. Options on narrow-based stock indexes
   Same as options on common stocks

3. Options on broad stock indexes
   Long put or call: 100 percent
   Short put or call: premium plus 10 percent of index value less out-of-the-money amount; minimum is premium plus 2 percent of index value

4. Options on (broad) stock index futures (S&P 500 futures on the CME)
   Long put or call: 100 percent
   Short put or call: premium plus futures margin less one-half amount option is out of the money; minimum is premium plus $1,000

5. Options on debt instruments (T-bonds, T-notes, T-bills)
   Long put or call: 100 percent
   Short put or call: premium plus $M less out-of-the-money amount; minimum premium plus $M'; M and M' vary according to underlying debt instrument

6. Options on debt futures contracts (T-bonds on the CBT)
   Long put or call: 100 percent
   Short put or call: same as option in stock index futures
7. Options on foreign currency
   Long put or call: 100 percent
   Short put or call: 130 percent of premium plus $750 less out-of-the-money amount

8. Options on foreign currency futures (D-mark on the CME)
   Long put or call: 100 percent
   Short put or call: same as options in stock index futures except that minimum margin is premium plus $400

Appendix B

Margin Requirements on Option Spread Positions

Margining of positions involving related options and futures is complex. This appendix contains Chicago Board of Trade margin regulation with respect to options on T-bond futures, which are representative of the margining of complex positions involving options on futures.

431.05 Margin on Options—Under the provisions of Rule 431.00, the Board hereby fixes the following minimum margins for option transactions (minimum margin requirements which go into effect when trading limits are increased are in parentheses):

A. U.S. Treasury Bond Options

1. Long put or long call
   Premium must be paid in full. See Regulation 2805.01.

2. Short call or short put
   Premium (marked-to-market) plus the greater of (a) the futures margin minus one half the amount (if any) that the option is out-of-the-money or (b) initial $750 ($1125), maintenance or hedging $600 ($900).

3. (a) Long future and short call
   or
   Premium (marked-to-market) plus the maximum of the (a) futures margin minus one half the amount that the option is in the money or (b) initial $750 ($1125), mainte-
(b) Short future and short put

4. Short call and short put (straddle)

Market value of both option premiums (marked to market) plus, the underlying futures margin.

5. Vertical Spreads—
   (one long call and one short call or one long put and one short put, with the same expiration date.)

(a) Long call (put) option strike price is less (greater) than or equal to the short call (put) option strike price.

(b) Long call (put) option strike price is greater (less) than the short call (put) option strike price.

Long option premium is paid in full. No margin is required for short option premium.

Long option is paid in full. Margin equals $200 per contract for option positions involving months which are 12 months or more apart plus the amount, if any, that the short option premium exceeds the long option premium plus, if the long option expires before the short option, initial $750 ($1000), maintenance or hedging $500 ($750).

6. Horizontal Spreads—
   (one long call and one short call or one short put and one long put, with different expiration dates.)

(a) Long call (put) option strike price is less (greater) than or equal to the short call (put) option strike price.

Long option premium is paid in full. Margin is equal to the difference between strike prices, not to exceed the margin requirements for the naked short option.
(b) Long call (put) option strike price is greater (less) than the short call (put) option strike price.

7. (a) Long call—short future

or

(b) Long put—long future

8. (a) Long call—short future—short put (reverse conversion) or

(b) Long put—long future—short call (conversion) assumes same expiration month for all three positions, and same strike prices for two option positions

9. Box Spread—(Long call vs. short put with the same exercise price coupled with a short call vs. long put with the same exercise price. All options in the same expiration month.)

(a) Credit Box—Long call/short put of higher strike price than short call/long put. (Total long option premiums paid in full. Margin is the difference in strike prices.)
short option premiums exceed total long option premiums."

(b) Debit Box—Long call/short put option at lower strike price than short call/long put option. (Total long option premiums exceed total short option premiums.)

10. Butterfly Spread—
One vertical bull spread (put or call) combined with one vertical bear spread (put or call). The spread shares one common strike price which is between the two other strike prices. All options expire on the same date.

(a) Debit Spread—
Total long premiums exceed total short premiums when position is established. Middle strike price is exactly halfway between outer strike prices.

(b) Credit Spread—
Short option premiums exceed long option premiums at time position is established. Middle strike price not halfway between outer strikes.

Long option premiums paid in full. No further margin required.

Long option premiums paid in full. No further margin required.

Long premiums paid in full. Margin equals largest difference between two adjacent strikes, not to exceed the futures margin plus the amount (marked-to-market) by which the short option premiums exceed long option premiums.
Appendix C

Margining Portfolios versus Margining Individual Securities

The minimum margin of an investor is given by

\[ V^*_0 = k\sigma(\hat{V}_t) \]  (C-1)

This is equation 11 in the text. We now consider some examples of particular simple portfolios and the appropriate margin for each.

Consider first a two-asset portfolio consisting of \( b \) units of riskless securities with face value of $1 paying \( R_{ft} \) interest and \( z_1 \) units of a futures contract, the current futures price of which is \( F_{10} \). The uncertain future value of this portfolio is

\[ \hat{V}_t = b(1 + R_{ft}) + z_1(\hat{F}_{1t} - F_{10}) \]  (C-2)

where \( \hat{F}_{1t} \) = the uncertain futures price at time \( t \). The current value of the portfolio is

\[ V_0 = b \]

The futures contracts do not enter into this current value because the current value of a futures contract is zero, since profits and losses are marked to market daily. The standard deviation of (C-2) is \( \sigma(\hat{V}_t) = z_1\sigma(\hat{F}_{1t}) \). For purposes of illustration assume the futures contract is for one bushel, \( k = 3 \), \( t = 14 \) days, \( \sigma(F_{1t}) = .20 \), and \( z_1 = 5,000 \) bushels. Then the minimum margin, given by (C-1), is \( V^*_0 = $3,000 \).

This implies that the current value of equity, which in this case is just the T-bill, must be at least $3,000. If, as is assumed here, the investor may pledge his portfolio rather than cash, there is no cost of margin because the investor earns a return of \( R_{ft} \). Margining systems that require cash to be posted are costly because the investor loses the earnings on his posted funds.

Consider now another portfolio identical with the preceding one except that a short position in a futures contract in the same commodity with a different maturity is also held. The uncertain future value of this portfolio is

\[ \hat{V}_t = b(1 + R_{ft}) + z_1(\hat{F}_{1t} - F_{10}) + z_2(\hat{F}_{2t} - F_{20}) \]  (C-3)

where \( z_2 < 0 \) = number of units of futures contracts held in a short position (a negative value indicates a short position); and \( \hat{F}_{2t} \) = the uncertain futures price at \( t \) of the second futures contract. The current value of the portfolio is \( V_O = b \).
The variance of (C-3) is
\[ \sigma^2(\tilde{V}_t) = z_1^2 \sigma^2(\tilde{F}_{1t}) + z_2^2 \sigma^2(\tilde{F}_{2t}) + 2z_1z_2\rho_{12}\sigma(\tilde{F}_1)\sigma(\tilde{F}_2) \]
where \( \rho = \) correlation between \( F_1 \) and \( F_2 \). Since (C-3) is a spread position, the variance will generally be less than the variance of (C-2) as long as the correlation of price changes in the two futures contracts is not too small. Assume that \( \rho = .9, \sigma(F_1) = \sigma(F_2) = .2, \)
\( z_1 = 5,000, \) and \( z_2 = -5,000. \) Then \( \sigma(\tilde{F}_t) = 447.2, \) and, assuming \( k = 3, V^* = $1,342. \)

Thus, when account is taken of the correlation of the two futures positions, the required margin is $1,342. If margins were calculated separately on each position, margin of $6,000 would have been required. Futures markets and options markets do account for various spread and hedge positions that reduce the portfolio risk in the manner just shown, but they do not take account of all combinations in the way that would be accomplished if the investor’s portfolio were the thing being margined.

In the case of options, the difficulty of taking account of a large number of offsetting options positions can result in overmargining, even when a premium-based margining system is used. Consider now, as a third example, a portfolio consisting of a riskless security and several options written on the same underlying asset, say a futures index. The options positions are long a call and short two other call options of different exercise prices or different maturity. The uncertain future value of this portfolio is
\[ \tilde{V}_t = b(1 + R_{ft}) + n_1\tilde{C}_{1t} + n_2\tilde{C}_{2t} + n_3\tilde{C}_{3t} \]
and the current value of the portfolio is
\[ V_O = b + n_1C_{10} + n_2C_{20} + n_3C_{30} \]
where \( n_i = \) number of options held long or short. A short position is indicated by a negative value. We assume \( n_1 > 0, n_2 < 0, \) and \( n_3 < 0. \) \( C_{i0} = \) current market value of the option premium.

The change in the call premium can be related to the change in the value of the underlying asset as follows:
\[ (\tilde{C}_{it} - C_{i0}) = h_i(\tilde{F}_t - F_O) + \tilde{e}_{it} \]
or
\[ \tilde{C}_{it} = C_{i0} + h_i(\tilde{F}_t - F_O) + \tilde{e}_{it} \]
where \( F_O \) is the present price of the futures index, which is the instrument underlying the option, and \( \tilde{F}_t \) is the uncertain future value of the underlying index. The coefficient, \( h_i, \) is the “delta” value of
option $i$ over the period $t$. It represents the amount of change in the option premium for a $1$ change in the futures index. Since this relation is not exact, a residual term, $\tilde{e}_{it}$, is necessary.

The uncertain future value of this portfolio can now be written as

$$V_t = b(1 + R_p) + \sum n_i C_i O + \left(\sum n_i h_i\right) (\tilde{F}_t - F_0) + \sum n_i \tilde{e}_{it} \quad (C-4)$$

The variance of (C-4) is

$$\sigma^2(V_t) = \left(\sum n_i h_i\right)^2 \sigma^2(\tilde{F}_t) + \sigma^2 \left(\sum n_i \tilde{e}_{it}\right)$$

We assume the following values for the three options:

<table>
<thead>
<tr>
<th>Options</th>
<th>$n$</th>
<th>$C$</th>
<th>$h$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100</td>
<td>30</td>
<td>.7</td>
</tr>
<tr>
<td>2</td>
<td>-100</td>
<td>8</td>
<td>.5</td>
</tr>
<tr>
<td>3</td>
<td>-100</td>
<td>2</td>
<td>.2</td>
</tr>
</tbody>
</table>

In addition, we assume $\sigma^2(\tilde{F}_t) = (1.15)^2$ and $\sigma^2(\sum n_i \tilde{e}_{it}) = (30)^2$. Given these values, $\sigma(V_t) = 30$, which is the standard deviation of the portfolio arising from the imperfect association of the option prices and index prices. Because $\sum n_i h_i = 0$, the index volatility has no bearing. The three option prices move in offsetting directions. In effect, they have a "systematic" risk of zero because their delta values sum to zero.

Assuming $k = 3$, the minimum margin is $V_0^* = $90. The current value of the portfolio is

$$V_0^* = b + 30 - 8 - 2 = b + 20 \quad (C-5)$$

This implies $b = 70$ as the minimum amount of cash or T-bills that must be pledged. This amount is quite different from what would be required if each option were considered in isolation or, indeed, if margin were calculated using the present pairing system. In effect, the margin calculated in equation C-5 is based on a delta margining system of the type also recommended by Figlewski. Such a system recognizes that margins on the same underlying instrument have the same underlying source of variability. Thus offsetting positions in such instruments provide a hedge and reduce the risk of the portfolio.

If one accepts the premise of this section that the optimal margin is the amount of equity an investor must possess to assure the broker
that the investor's obligations can be met in the face of adverse price changes over some period of time, then what is to be margined is not a particular security but the portfolio of the investor taken as a whole.

Notes


3. The topic of appropriate margin is discussed in greater detail later in this chapter.


7. For a view that regulatory competition is desirable, see Edward J. Kane, "Regulatory Structure in Futures Markets: Jurisdictional Competition between the SEC, the CFTC, and Other Agencies," Journal of Futures Markets, vol. 4 (Fall 1984), pp. 367-84.


10. More recently, in 1978, trading in unregulated "London options" was banned because of fraudulent sales practices that included bucket shops, high-pressure sales, and "Ponzi" schemes.


14. Implicit in this claim is a distinction between manipulation based solely on trading activity and manipulation based on misstatements of fact, inside information, and fraudulent publicity. The former is difficult to detect and sometimes difficult to condemn: is a block trader a manipulator? The latter are clearer cases of manipulation.


17. See, for example, Mehl, *Trading in Privileges*.

18. Robbins et al., "Impact of Exchange-traded Options."

19. For a discussion of the specific nature that this futures position must take, see Hans R. Stoll and Robert E. Whaley, "New Options Instruments: Arbitrageable Linkages and Valuation" (Paper prepared for Money, Banking, and Insurance Symposium, University of Karlsruhe, West Germany, December 1984).

20. Most nonagricultural commodities, such as financial assets and precious metals, are always in a "full carry" market. Agricultural commodity prices, however, are frequently inverted before a new harvest. We can accommodate this fact simply by letting $b$ be negative. More critical is our assumption of constant $b$, which is not likely to be satisfied in an inverted market, where changing expectations of the coming harvest cause frequent unanticipated changes in the relation of spot and futures prices (and thus the value of $b$).

22. To see this, note that if $X > S$, the value of the put is $X - S$, and the value of the short call is 0. Alternatively, if $X < S$, the value of the put is 0, but the value of the short call is $X - S$. Thus, regardless of the final asset price, the value of the long put–short call position is $X - S$. Figure 4–4 shows this position after premium income or premium payments.

23. Stoll and Whaley, "New Options Instruments."

24. Where the underlying asset is a non-dividend-paying stock, the cost of carry is the interest rate, and the put-call parity for American stock options is

$$S - X \leq C(S,T,X) - P(S,T,X) \leq S - Xe^{-rT}$$

25. The exact portfolio compositions necessary to derive the put-call parity relations 3 and 4 are provided in Stoll and Whaley, "New Options Instruments."


28. Stoll, "Relationship between Put and Call Prices."


35. Stoll and Whaley, "New Options Instruments."


37. Chin, "Foreign Currency Options."


39. Chin, "Foreign Currency Options."

40. Lester Telser and Harlow Higinbotham, "Organized Futures Markets:
Deliverability also usually meant storability. Futures markets do exist, however, in nonstorable commodities, such as fresh eggs.

For a detailed discussion of these issues, see Allan B. Paul, in "The Role of Cash Settlement in Futures Contract Specifications," in Peck, Futures Markets: Regulatory Issues.


See Smidt, "Trading Floor Practices."

The AMEX and the Philadelphia Stock Exchange plan to start commodity units to trade futures and options. Their product is distinguished from that of futures exchanges primarily by the trading mechanism—a board broker (as on the CBOE)—and a prohibition against dual trading. See "American and Philadelphia Exchanges Are About to Start Up Commodity Units," Wall Street Journal, April 18, 1985.


The futures contract on the S&P 100 index was not, however, introduced until July 14, 1983.

The cross-sectional geometric averaging of stock prices to compute the Value Line index reduces the covariability of price changes in the index with price changes in a stock portfolio. The options on the Value Line futures index will therefore be less effective for hedging and portfolio management.


Ibid.


54. In futures markets, margin requirements are also established by the clearinghouse for clearing members. Clearing members establish margins for futures commission merchants (FCMs), who establish customer margins. The customer margins established by an exchange are the minimum margins required of customers. For a more complete discussion of futures margining practice, see Edwards, "Clearing Association in Futures Markets"; and William Tomek, "Margins on Futures Contracts: Their Economic Roles and Regulation," in Peck, Futures Markets: Regulatory Issues.

55. Figlewski, "Margins and Market Integrity."

56. We are not concerned with the credit control rationale applicable in stock and bond markets.


58. Figlewski, "Margins and Market Integrity."

59. Margins established by the clearinghouse for its members or by clearing members for FCMs also depend on the existence and nature of other regulations for ensuring the financial integrity of firms. These include the existence of requirements to regulate customers' margin deposits and other funds, the existence of required reserve accounts, and the existence of capital requirements.

60. Figlewski, "Margins and Market Integrity."

61. The distribution of the terminal portfolio value is assumed to be normal; if it is not, modifications must be made in the analysis.

62. Asay, "Design of Commodity Option Contracts."


64. See letters dated January 11, 1985, from Paul A. Volcker to Senator Jesse Helms, chairman of the Committee on Agriculture, Nutrition, and Forestry, accompanying submission of Federal Reserve Board, Federal Margin Regulation.


66. Figlewski, "Margins and Market Integrity."