CHAPTER 3

The Building Blocks of Functional Analysis

> Twenty-five years ago it was comparatively easy to acquire a sound knowledge of the general investment field...(but now)...the different types of securities have multiplied in number to an almost unlimited extent....(T)he different types of (securities) which are daily sought for investment nowadays are often so different...that not only must each class be judged by itself, but a great many issues of the same general class have distinct traits which go far to affect directly their position and value as investments.
>
> *John Moody, 1910*[1]

> The array of derivatives contracts is not as complex as it first appears. Every derivatives transaction can be built up from two simple and fundamental types of building blocks: forwards and options.
>
> *G-30 Overview, 1993*

As with any other business activity, a primary concern of senior management and its legal advisers regarding the use of a derivative product is the potential effect on the organization's overall competitive strategy. According to Professor Michael Porter of Harvard University's Graduate School of Business Administration, "[A]t general management's core is strategy: defining a company's position, making *trade-offs*, and forging *fit* among activities." Further, "competitive advantage comes from the way [an organization's] activities *fit* and reinforce one another."[2] If the derivative enhances a portfolio or firm's other activities, it contributes to long-term organizational competitiveness. If it is incompatible with other activities, it drains resources, especially management resources, and can create other operating inefficiencies.

Fundamental to understanding whether a product will fit with other activities in an organization's overall competitive strategy is a functional analysis of:

1. The derivative
2. The assets or liabilities with which it is to be combined
3. The economic behavior of the resulting combination

A functional approach begins with an analysis of an individual product's and investment risk and return characteristics. Next, it analyzes the way the product combines, interacts, or fits with other assets, liabilities, and business activities.

ANALYZING ECONOMIC RISK AND RETURN CHARACTERISTICS

The first step in a functional analysis is to determine the individual product's economic risk and return characteristics. For most senior managers and legal advisers, an in-depth knowledge of derivatives' pricing is usually not essential—senior managers and lawyers do not have to be "math whizzes," "rocket scientists," or "number crunchers." Nevertheless, a basic understanding of the behavioral characteristics of any product under consideration is essential.

At the core of such understanding is the knowledge of the "basic building blocks" from which every derivative product is constructed—forwards and options. Every product, whether a "plain vanilla" transaction or a complex hybrid instrument, can be deconstructed, or "reverse-engineered," into its basic building blocks. Reverse engineering isolates and categorizes the individual risk components of every derivative, and it simplifies the understanding of the nature and magnitude of each component.

Forward-Based Contracts

The simplest building block is a forward contract, which "obligates one counterparty to buy, and the other to sell, a specific underlying [asset, rate, index, or commodity] at a specific price, amount, and date in the future." (We will refer to the underlying asset, rate, index, or commodity as a hypothetical instrument called a *fidget*—the financial instrument equivalent of a widget.)* "Forward markets exist for a multitude of underlying [fidgets],

*Before objecting that *fidget* seems a frivolous term, consider the problems inherent in the common alternatives, such as *cash, actual, spot, variable,* and *underlying*. As Holbrook Working wrote in 1953, each alternative is certainly well understood by those "who are intimately acquainted with…trading and its consequences"; yet its "usage is a bit frustrating and even misleading" to nontraders (who Working calls "inquiring novices").

Cash, a convenient term for traders, conveys little information to nontraders. Why? "Its application involved two shifts of meaning: (1) use of 'cash' to designate, not immediate *payment*, as is usual, but immediate *delivery*; and (2) extension of the altered meaning to cover all terms of delivery except those involved in futures contracts. These changes left the word with *no logical merit for the purpose except its brevity*.…Most seriously misleading is frequent resort to the use of '*actual*.'" Similarly, consider that commodities markets often employ the oxymoron "*spot-deferred* transactions."

Finally, experience teaches that when "inquiring novices" encounter a term such as the *variable* or *underlying*, they invariably wonder: The variable or underlying what? Sometimes they voice their question, and the problem is easily solved. More often they do not, and needless misunderstandings ensue. See generally Working, *Futures Trading and Hedging, supra,* Chapter 1, note 3 (emphasis modified): 314–343.

including the traditional agricultural or physical commodities, as well as currencies (referred to as foreign exchange forwards) and interest rates (referred to as forward rate agreements or 'FRAs')."[3] The reason a forward contract is the simplest derivative is that its value ordinarily changes in direct proportion to changes in the price of the underlying fidget. Consequently, calculation of the forward contract's expected value is relatively easy, and its price sensitivity to changes in the price of the underlying fidget can be plotted linearly.*

Any calculation of forward prices begins from the underlying fidget's current *spot price*. A spot price on any date is simply the market price for immediate delivery of the fidget on that date. Spot prices, which are determined by supply and demand, ordinarily fluctuate over the time period between the date the contract is entered into (the contract date) and the forward delivery date specified in the contract.

Gain or loss on a forward is determined primarily by the difference between the spot price on the delivery date and the purchase price set forth in the contract (the contract price). If on the delivery date spot prices *exceed* the contract price, the *buyer*—often referred to as the holder of the "long" position—of the underlying realizes a *gain* on the forward, and the seller, or "short," realizes a loss, each equal in an amount to the difference between the two prices. The reason is that the price of the fidget on the delivery date will be cheaper under the contract than it is on the open market.† Conversely, if the delivery date spot price is *less* than the contract price, the buyer realizes a loss and the seller a gain.

The payoff profiles of both long and short positions in a forward contract are depicted in Figure 3.1. In each case, the price of the underlying fidget is indicated by the horizontal axis, and the contract price is indicated by the point at which each diagonal line intersects the horizontal axis. The positions of the long and the short are exactly offsetting; thus a gain for the long is an equivalent loss for the short, and vice versa.

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*Ease of calculation results in ease of price (or value) monitoring and, hence, risk management. This contrasts markedly with option-based products, the pricing and risk management of which, as we will see, are far more involved and subject to much theoretical and practical debate. Plotting reveals that an option's price sensitivity is *curved* and always changing, unlike that of a forward, which is linear and constant.

†The contract will be valuable to the long whether or not it chooses to take delivery. The reason is that the long can always sell the contract to a third party who wishes to take delivery. In a competitive market, that third party should be willing to pay up to the amount of the savings it would realize by purchasing the underlying fidget pursuant to the forward contract rather than on the spot market.

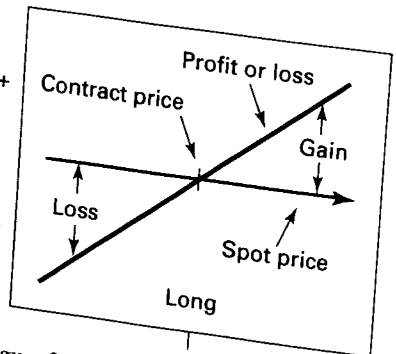

Figure 3–1*a* Long forward position.

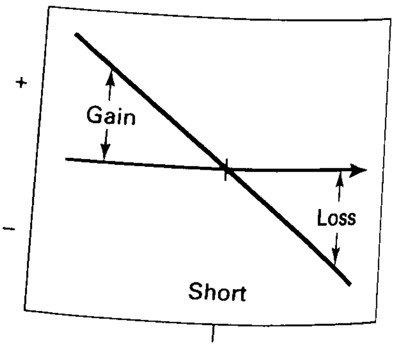

Figure 3–1*b* Short forward position.

Forwards are OTC transactions. Therefore, their price, delivery, credit, and other terms are subject to negotiation. "At the time the [forward] contract is entered into, the delivery price is chosen so that the value of the forward contract to both parties is zero. This means that *it costs nothing to take either a long or a short position.*"[4] As Nasser Saber explains, forward contracts are agreements to enter into exchanges, and rational market participants "will only agree to an exchange of equal values." Therefore, the net present value* of the exchange to both sides at the time of contract formation "must be zero."[5]

The zero net present value feature of a forward-based transaction means that it commences as neither an asset nor a liability.[6] (For accounting purposes, as we discuss later, it has, then, no "historical cost" capable of being booked as a balance sheet item.) However, a contract that begins as neither an asset nor a liability can quickly become one or the other. The ability to enter into a forward-based contract with little, in the case of futures, or no money down is the primary source of the contract's *leverage*—that is, its potentially dramatic responsiveness to even small changes in the value of the underlying fidget.

Normally, a forward contract's value fluctuates over the contract's life as the following example demonstrates. "The easiest forward contract to value is one written on a security that provides the holder with no income. Nondividend paying stocks and discount bonds are examples of such securities."[7] Assume that today's spot price for a share of LMN com-

*Net present value means the face amount of the future payment, reduced by a discount factor appropriate to compensate the recipient for the opportunity cost of delayed the payment (and, with physical commodities, for storage, insurance, and delivery costs).

mon stock, which pays no dividend, is $10 and that the applicable "risk-free" interest rate is 5%.* The theoretical forward price of a round lot (100 shares) of LMN common stock for delivery one year from today is $1050, or the sum of today's $1000 spot price *plus* a $50 financing charge ($1000 × 5%). The financing charge is the cost of inducing the seller to wait one year before receiving payment for its LMN shares.

A seller must be paid to wait, because waiting to consummate the sale implies an opportunity cost to the seller. If the seller were instead to sell on today's spot market, it would receive its $1000 immediately. The seller could then invest that $1000 for one year, earning a risk-free return of $50.† If the risk-free rate were to rise to 6% prior to the contract date, the seller would demand an implied financing charge of $60. If the current spot price were also to decline to $9, the buyer would be willing to pay only $9 per share. The forward price would be $954, or $900 *plus* a $54 financing charge ($900 × 6%). Thus, the primary reason forward prices of financial instruments fluctuate is that spot prices, market interest rates, or both fluctuate.

Finally, all forward-based transactions create *two-way credit exposures,* because actual exchanges of value occur only at maturity. It is possible for either party to a forward to incur a loss or a gain, and therefore both are exposed to credit risk, or the risk of counterparty default.

For many end users, the two-way nature of credit risk is often the *central feature* distinguishing forwards from other types of credit transactions. Although most nonfinancial organizations purchase investment

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*Often, the "risk-free" rate is the *repo rate.* "A *repo* or *repurchase agreement* is an agreement where the owner of securities agrees to sell them to a counterparty and buy them back at a slightly higher price later." Hull, *Derivatives, supra,* note 3: 50. The repo rate is considered risk-free, because a repo is economically equivalent to a loan in which the securities purchased with the loan proceeds fully collateralize the repayment obligation. "The difference between the price at which the securities are sold and the price at which they are repurchased is the interest earned by the counterparty. If structured carefully, a repo involves very little risk to either side. For example, if the borrowing [i.e., securities-buying] company does not keep to its side of the agreement [i.e., does not repurchase the securities or repay the loan], the lender simply keeps the securities." *Id.*

†Alternatively, if the seller does not own the LMN shares on the contract date, pricing theory assumes the seller will purchase the shares at today's spot price to "cover" its future delivery obligation. Otherwise, it runs the risk that spot prices will rise on or before it has a chance to cover. The seller is assumed to obtain funding for today's spot purchase price by borrowing at 5%.

Viewed differently, the discounted present value of the $1050 to be received in one year is $1050/(1.05) = $1000.

securities in their normal treasury operations and often borrow money, end users seldom act as outright lenders in arm's-length loan transactions. Therefore, the credit and legal analysis required for a proper assessment of the risks of forward-based derivatives may be unfamiliar to the end user and its legal advisers.

Credit risk creates exposures equal to a contract's replacement cost, or market value, which for forwards is the net present value of all future cashflows. Positive (negative) market value to one counterparty is negative (positive) to the other. A party whose contract has positive market value is "in the money" and has extended credit to the other party, which is "out of the money." Proper credit risk management begins with calculations of a portfolio's actual, or current credit exposure. Counterparties should also track future, or potential exposure based both on expectations of probable future market conditions and on worst-case scenarios.

Swaps: Combinations of Forwards

The basic building blocks of a swap are forward contracts. Chapter 2 contains examples of plain vanilla currency and interest rate swaps. Swaps constitute a series of simple forward contracts. An interest rate swap, for example, involves an exchange of interest payments on each designated future payment date. Each exchange can be analyzed and valued as a separate, individual forward contract. A currency swap is comparable, except that many involve initial spot exchanges of principal.

> As the name implies, a [plain vanilla] swap transaction obligates the two parties to the contract to exchange a series of cash flows at specified intervals known as payment or settlement dates.... The cash flows from a swap can be decomposed into equivalent cash flows from a bundle of simpler forward contracts. For example, an interest rate swap can be decomposed in terms of cash flows into a portfolio of single payment forward contracts on interest rates. At each settlement date, the loss or gain in the currently maturing implicit forward contract is in effect realized."[8]

One reason swap markets have flourished is that the products' forward-based composition allows for relative ease of calculating swap prices. It also allows for simplicity of reconfiguring cashflows into any number of variations designed to meet an end user's cashflow needs. A wide variety of swaps is readily available. Among them are "amortizing" swaps, which have reducing notional amounts; "canapé" currency swaps, involving no initial or final exchanges of principal; "zero coupon" swaps, in which one side makes no payments until the final maturity date; and "forward swaps," which do not commence until a future date.

As discussed earlier, the objective in designing a forward-based contract (in this case, a swap) is to ensure that at the outset the net present value of all exchanges of the payments to be made by both sides will equal zero. The determination of the net present value of each side's obligations is simply a summation of the net present values of each of its payment obligations. Although the number of calculations (and iterations of the same calculations) necessary to determine and equalize the net present values of the two sides' payment obligations can be quite large, the calculation structure is straightforward.

Swaps contain two pricing uncertainties. First, usually one or both sides of the transaction will be making floating-rate payments, and therefore the floating-rate pay or can only estimate the face amount of any future payments to be made. Estimates depend on one's assessment of likely future interest rates (but *not* on the likely movement of underlying fidgets, such as commodity prices or equity values). Second, the discounting process requires assumptions about applicable interest rates to be used to discount future payments to present value, and those rates usually change during the life of the swap. Thus, the value of a swap will, over time, change as applicable rates change. Nevertheless, the calculation structure will remain constant. Therefore, for valuation purposes, the effect of each change in applicable rates can be determined simply by substituting the new rates into the original formula.

Futures: Highly Standardized Forwards Traded on Organized Exchanges

A futures contract, like a forward, is an agreement of one party to buy and the other to sell a specific underlying fidget at a specific price, amount, and date (or over a specified time period*) in the future. Futures are, essentially, forward contracts traded on organized futures exchanges. Their payoff profiles are identical to those of forwards described in Figure 3.1. Futures exchanges originally handled agricultural commodities, but "[t]he

*"One way in which a futures contract is different from a forward contract is that an exact delivery date is not usually specified. The contract is referred to by its delivery month, and the exchange specifies the period during the month when delivery must be made." Hull, *Derivatives*, *supra*, note 3: 4.

volume of the newer financial futures contracts involving interest rates, currencies, and equity indices now dwarfs the volume in traditional agricultural contracts."[9] Economically, futures contracts have four essential features.

First, to be eligible for exchange trading, a futures contract must conform to the applicable fully standardized features specified by the exchange. Standardization covers all aspects of a contract except price. Price is determined on major exchanges simply through an "open-outcry method" on futures trading pits that on many exchanges continues to survive despite technological advances that might otherwise appear to render the open-outcry method obsolete. Thus, the quantity and quality of the underlying fidget is specified by the exchange, as are the time, place, and method of payment or settlement.

Second, "standardization extends to the credit risk of futures. Credit risk is greatly reduced by marking the contract to market with daily (or more frequent) settling up of changes and value, and by requiring buyers and sellers alike to post margin as collateral for these settlement payments."[10] The margin requirement takes two forms and applies to each party to the transaction. First, both the buyer and the seller of the underlying fidget must post an initial margin at the outset of each contract, limiting to some extent the leveraging ability of futures market participants. Second, a party must post a "variation margin" each time the market moves against it by a specified amount, called a *tick.*

The frequent marking to market and posting of margin means that parties to futures contracts easily and constantly monitor changes in the value of an open position, settling losses and gains incrementally rather than all at once on contract maturity. On the delivery date for a financial futures contract, the market value of the contract will equal the spot price of the underlying fidget. The process by which prices move toward equality is known in futures markets as *convergence.* For contracting parties, the margining and collateralization process has two drawbacks in that it entails higher administrative costs and results in unpredictable cashflows when compared with forward-based products such as swaps.

Third, the immediate counterparty to every futures contract is a futures clearinghouse, essentially the middleman between contracting parties. Consequently, the credit risk to each counterparty to a futures contract is that of the clearinghouse. This feature further greatly reduces counterparty credit risk, because exchanges are funded by their members and enjoy the highest credit ratings. Generally, futures contracts are entered into and traded freely without concern about clearinghouse default, or counterparty credit risk.*

Finally, the minimization of credit risk in futures transactions means that, unlike participants in OTS forwards and swaps markets, can afford to remain anonymous. "The futures market...is an impersonal market in which there is no premium on knowing one's counterparty. The moral hazard of trading with strangers is solved by interposing an intermediary—the clearinghouse."[11] In addition, relatively small minimum contract sizes make futures contracts more readily available to retail investors than swaps and forwards, which are almost exclusively transactions between institutions (with perhaps equity swaps being the most notable exception).

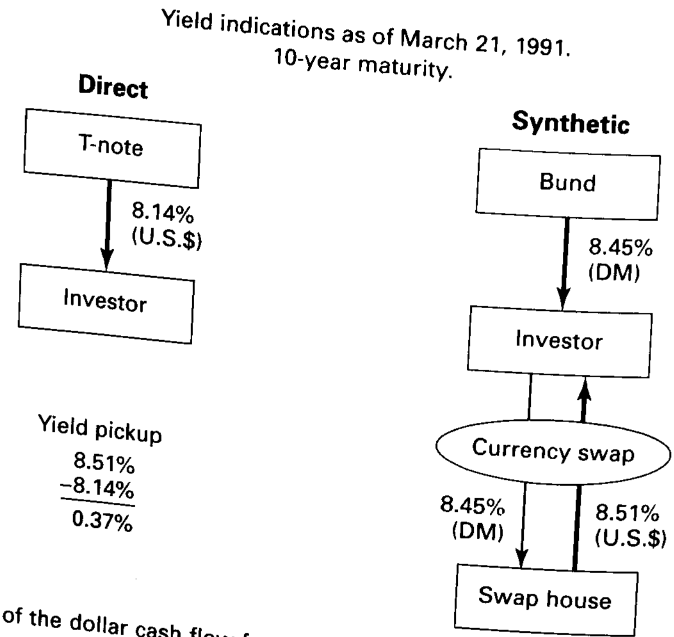
Unbundling Forward-Based Transactions

Swaps and futures are relatively simple contracts to unbundle into their forward-based building blocks. However, the functional approach can also analyze the risks of more complicated structured transactions, as the following two examples demonstrate. Both structures manage currency exchange risks; the second also manages the spot price risks of oil and rice on behalf of an oil-producing nation that imports rice from Japan.

Creating a synthetic asset

Figure 3.2 diagrams a transaction designed in 1991 to enable an investor who had customarily held U.S. Treasuries to achieve its goal of improving its returns. The investor desired to invest instead in German "bunds" yielding 31 basis points more than comparable U.S. Treasuries. Bunds are German government bonds denominated and payable in deutshemarks (DM). As an alternative to purchasing a 10-year U.S. Treasury yielding 8.14%, the investor purchased an 8.45% 10-year bund and simultaneously entered into a matching currency swap. Under the swap, the investor agreed to exchange its DM cashflows over the life of the swap for U.S. dol-

*However, concerns about clearinghouse creditworthiness are not purely academic. An example is provided by "the collapse of the International Tin Council in 1986 and the fallout for the London Metals Exchange. To cope with large defaults, some exchanges explicitly insure contracts, raise assessments on members, or make special calls on them." See Hargreaves, *Swaps: Versatility at Controlled Risk.*



Measures of the dollar cash flow from a U.S. Treasury note compared with that from a German government bond (Bund) with its mark cash flow swapped into dollars. Against the yield pickup the investor would sacrifice a degree of liquidity, assume credit risk on the German government and the swap house, and be open to price risk if the maturities of cash flows of the Bund and swap fail to match exactly those of the Treasury note.

Figure 3.2 Synthetic asset for investors. (*Reproduced with permission from J.P. Morgan & Co. Incorporated.*)

lars. The net result (prior to transaction costs and without regard to tax effects) was an increased yield of 37 basis points.

The first step in a functional analysis of the transaction is to unbundle the risks the investor would have faced had it invested in the bunds directly without a swap. The obvious risk was that after buying the bund the dollar would strong then against the mark–i.e., U.S. $/DM exchange rate risk (assuming the investor desired to convert DM proceeds into U.S. dollars). A lesser risk was that of a German government default. Although the investor was comfortable with the default risk, it would not accept currency risk. To purchase the bund the investor needed to shed the unwanted currency risk. The swap enabled the investor to do precisely that.

However, the swap introduced two additional economic risks for the investor to consider, as well as one other risk about which it may have had concerns. The first was the risk of default of the dealer swap counterparty. The second risk stems from the possibility that the investor might over the 10-year life of the structure have desired to liquidate the investment early and sell the bund prior to the maturity of the swap. In that case, the investor might have been left with a swap for which it had no obvious use as a hedging instrument. Aside from possible adverse tax and accounting consequences, that result would have left the investor in precisely the same position it had set out to avoid—namely, exposed to U.S. $/DM currency exchange risk.

Had it liquidated the investment early, the investor would have had to either terminate the swap or assign it, perhaps the bund purchaser. The investor would have needed the legal right to assign the swap. Swap assignments are, however, usually contractually prohibited (see, e.g., section 7 of the ISDA Master Agreement) because they expose the other side ti the credit risk of a new conterparty. They are also more cumbersome than early terminations. Therefore, early termination would have been the more likely choice of all parties.* If the assignee desired a swap, it could easily enter into one on its own.

One other risk with which the investor may have been concerned, especially a public company or regulated entity, was that of holding an OTC derivative and engaging in a potentially "suspect" activity.

Synthetic barter

Figure 3.3 depicts a complex transaction in which a number of plain vanilla swaps were combined to achieve a remarkable result. The structure involved two plain vanilla commodity swaps, a plain vanilla currency swap, and a plain vanilla interest rate swap. The result was a synthetic barter arrangement that enabled an oil-producing nation to obtain a long-term supply of rice in exchange for a fixed long-term quantity of oil.

Prior to the transaction, the practice of the oil-producing nation was simply to sell oil on the spot market for U.S. dollars. It would then convert those dollars into Japanese yen and purchase rice in Japan on the spot market. The nation had exposure to three separate price risks: "the price of oil

*In evaluating the all-in cost of the structure, the investor needs to consider the potential of early termination costs. Swap terminations require the payment of a termination value to the in-the-money party. The termination value is usually the market value of the swap. However, a dealer would also charge a bid-asked spread, because early termination is economically the same as entering into a new swap with exactly offsetting terms.

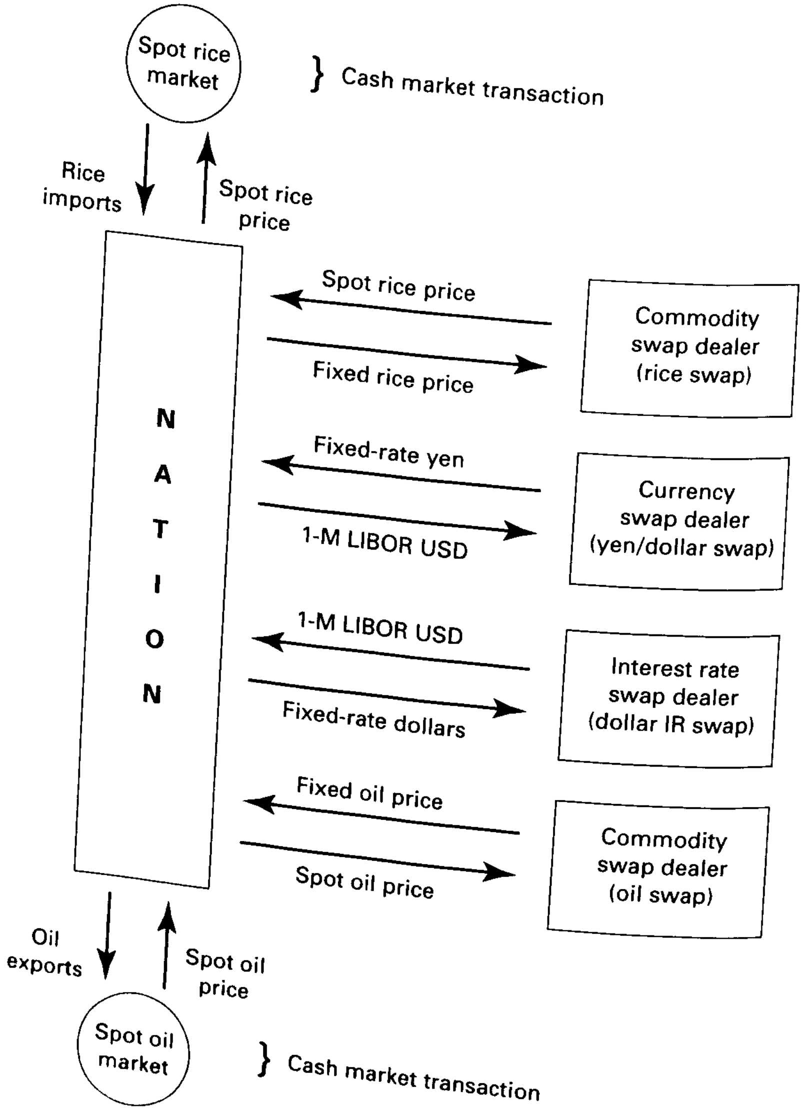


Figure 3.3 Synthetic barter. (*Reproduced with permission from Warren, Gorham & Lamont.*)

in dollars, the price of rice in yen, and the price of yen in dollars."[12] The transaction structure mitigated all three of those risks.

Although the structure is complicated and the complete details were unavailable,* the transaction exhibits the following cash and commodity flows. First, a commodity swap was entered into under which the oil producer locked in a long-term fixed dollar price for selling future specified oil production. Next, those dollars were indirectly converted into a fixed number of yen using a combination of (1) a fixed-for-floating U.S. dollar denominated interest rate swap followed by (2) a floating-rate dollar for fixed-rate yen currency swap. Finally, the fixed-rate yen (the amount of which was now also locked in) were converted, through a commodity swap, into the yen needed to buy a fixed quantity of rice on the spot market.

The primary risk introduced by the synthetic barter structure was the chain of counterparty risks arising from the possibility of involving up to four separate dealers in the transaction.†

Option-Based Contracts

"The other derivatives building block is the option contract."[13] All option-based products can be analyzed in terms of the two basic types of options: *puts* and *calls*. Because each put and call has two sides, a *long* and a *short*, "four basic option positions are possible": one can be long or short a put or a call. From those basic positions, together with long and short positions in forwards and underlying fidgets, a limitless number of other positions can be constructed‡

*A detailed analysis is scheduled to be published in Marshall and Wynne, "Synthesizing Countertrade Solutions with Swaps," *Global Finance Journal.*

†As with the preceding synthetic asset example, the oil-producing nation should consider, in evaluating the all-in cost of the structure, the possible costs of early termination. In the prior example, we noted that a bid-asked spread would be at issue in an early termination of the currency swap. Here, each swap would have its own bid-asked spread, so a total of four spread costs must be contemplated.

‡Discussions of options and option pricing can become extremely technical. Two classic authoritative texts, each of which explores the subject in great technical and theoretical detail, are Hull, *Derivatives, supra,* note 3, and Cox and Rubenstein, *Options Markets, (Prentice-Hall, 1985)* For the senior manager or lawyer seeking more general, less technical discussions that are nevertheless quite relevant in exploring issues of direct concern to derivatives risk management, see *G-30 Overview* and Chew, *Leverage, supra,* Chapter 1, note 1 (and introduction by Robert C. Merton).

Options are typically defined from the perspective of the option holder as a right, not an obligation.[14]

> In exchange for payment of a premium, an option contract gives the option holder the right *but not the obligation* to buy [i.e., a call] or sell [i.e., a put] the underlying (or settle the value for cash) at a price, called the strike price, during a period or on a specific date. Thus, the owner of the option can choose not to exercise the option and let it expire. The buyer benefits from favorable movements in the price of the underlying but is not exposed to corresponding losses.[15]

Thus defined, "'[t]he advantage of options over swaps and forwards is that options give the buyer the desired protection while allowing him to benefit from a favourable movement in the underlying price.'"[16]

However, in managing risk—both economic and legal—it is equally important to note the *disadvantage* of buying options. In particular, the buyer of an option, unlike a party entering into a swap or forward, must pay a premium to enter into the option contract. An option buyer is not exposed to losses in the price of the underlying fidget. Nevertheless, the buyer is still exposed to a smaller, albeit certain *cost* because of the premium that must be paid. Much like an insurance policy, this premium "substitutes a sure loss for the possibility of a larger loss."[17] If the call expires worthless, the payment of the premium constitutes an overall loss on the option; if at expiration the call is in the money, the payment of the premium reduces the holder's overall gain on the option. Likewise, the cost of the premium reduces any gain from favorable price movements. An accurate assessment of the economic performance of any option-based strategy or instrument requires that the premium be taken into account. Although that point may seem obvious, its significance can also easily be missed.*

*One article provocatively asserts: "In the absence of market imperfections, options strategies may simply be the best way for treasury to speculate with corporate funds while escaping the scrutiny of senior management, shareholders, and others." Ian H. Giddy and Gunter Dufey, "Uses and Abuses of Currency Options," *Journal of Applied Corporate Finance* (Fall 1995):49–57. For a convincing rebuttal, see Christopher S. Bourdain, "FX Option Myths that Aren't," *Derivatives Strategy*, 1(5) (April 1996). On a related note, Tufano mentions a director of a well-known U.S. consumer-products corporation [who] went out of his way to defend one of the company's financial transactions: 'We just bought *puts* to hedge our foreign currency risk, but we're not involved with derivatives.' My well-meaning acquaintance was attempting to distance himself and his organization from the 'd' word, despite the fact that options are in fact derivatives." *Using Derivatives: What Senior Managers Must Know*, *supra*, note 2: 35.

Expiration payoffs; Intrinsic Value

An examination of option payoff profiles at expiration is the beginning of an understanding of the economics of options. Payoff profiles can be determined solely from an option's *intrinsic value,* which at any time is simply "the maximum of zero and the value [the option] would have if exercised immediately."[18]* The intrinsic value of a call is the amount (if positive) by which the then market value of the fidget exceeds the call's strike price. Conversely, the intrinsic value of a put is the amount (if positive) by which the put's strike price exceeds the then market value of the fidget. An option's expiration payoff is simply its *intrinsic value* at expiration, as measured from the perspective of the *holder,* or the *long.* The issuer, or *writer,* of an option is referred to as the *short.*

Figure 3.4 portrays the expiration payoff profiles to the option holder of both a call and a put. In each case, underlying spot fidget prices are indicated by the horizontal axis. Strike prices are indicated at each point marked "X." The point at which each diagonal line crosses above the horizontal axis is the option buyer's "breakeven point," meaning it has earned back its premium. Thus, if at the call's expiration the spot price *exceeds* the strike price, the holder will exercise the option. In contrast, if at the put's expiration the spotprice is *less than* the strike price, the holder will exercise the put. Yet that "the option has moved into-the-money does not necessar-

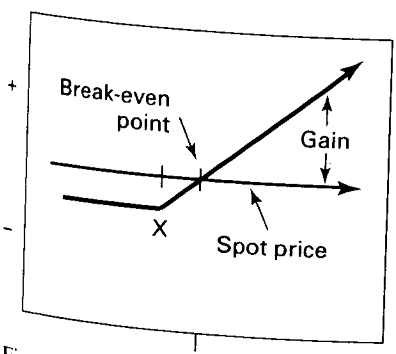


Figure 3.4*a* Long call.

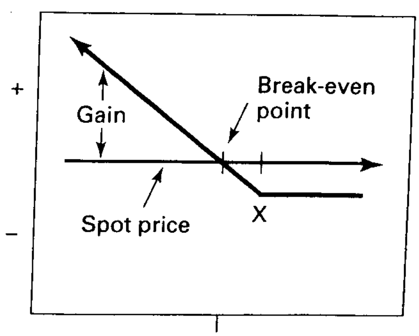


Figure 3.4*b* Long put.

*Intrinsic value is never negative, because option pricing theory holds that a rational holders will not exercise an option if doing so would cause them to lose money—that is, if the strike price of a call (put) exceeds (is less then) the market price of the fidget. The holder could more cheaply buy (or profitably sell) the fidget on the open market.

ily imply that the transaction has been profitable, as the initial premium paid must be subtracted from the in-the-money amount to come up with a profit margin."[19]

For both economic and legal risk management purposes, it is imperative to understand the risk options pose to the option writer. In *Derivatives Risks and Speculative Capital,* Saber notes that options are typically (as in the *G-30 Overview*) defined from the holder's perspective. From the perspective of the option writer, an option is a contract that *obligates* the writer, in exchange for a premium, to sell (in the case of a call) or buy (a put) the underlying fidget (or settle the value for cash) at the strike price during the option period or on a specified date.

Figure 3.5 portrays the expiration payoff profiles to the option writer, or issuer, of both calls and puts. In each case, underlying fidget prices are again indicated by the horizontal axis and strike prices are indicated by the point "X." The point at which each diagonal line crosses the horizontal axis is the option issuer's "breakeven point." In other words, if at expiration fidget prices are between the breakeven point and the strike price, the holder will exercise its option and the writer must make a payment—yet the payment will not be a loss to the issuer but merely a return of all or part of the premium previously received.

Option valuation prior to expiration is considerably more complex than the valuation of forwards, for several reasons. After the contract date the value of a forward is determined by, and fluctuates primarily according to changes in, two variables: (1) the spot price of the underlying fidget and (2) the level of prevailing risk-free interest rates. The value of each of those variables can be obtained objectively from a newspaper, by tele-

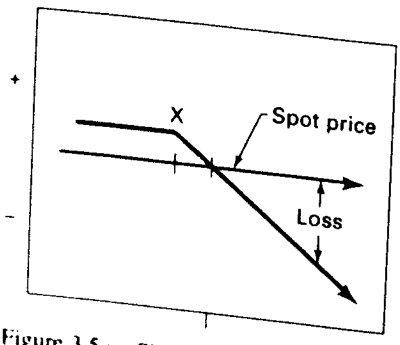


Figure 3.5*a* Short call.

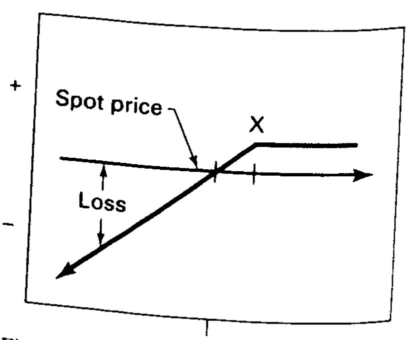


Figure 3.5*b* Short put.

phone, or from a screen-based quotation system.[20] The same variables are involved in the determination of an option's price. Yet, option prices also depend on, and fluctuate with changes in, three additional factors: (3) the strike price, (4) the time to expiration, and (5) the anticipated volatility of underlying fidget prices. The strike price (which remains constant throughout the option's life) and time to expiration (which decreases over the option's life) are determined at the outset of the contract through negotiation.

TIME VALUE

The value of a forward contract can be calculated relatively easily and plotted linearly, because of its dependence on only the first two variables, spot prices and interest rates. Similarly, the *intrinsic value,* defined as the value of the option at expiration, can be plotted straightforwardly, as in Figures 3.4 and 3.5. However, the valuation of options prior to expiration is a more complicated matter, because in addition to intrinsic value options have *time value.* Although the mathematics of time value are extraordinarily complex, conceptually time value is simply the value that is attributable to *uncertainty* regarding the price of the underlying fidget over time prior to expiration.

An intuitive grasp of the time value of an option is easily within reach without mathematics. Consider the value of a call option prior to expiration under the following circumstances. Assume the intrinsic value is zero, because the price of the underlying fidget is below the strike price—no rational person would exercise a call option at a price below the strike price. Nevertheless, a call option with no intrinsic value prior to expiration obviously still has some value, because some time prior to expiration the fidget prices *might rise* above the strike price. Similarly, an in-the-money call option has both intrinsic and time value, because no matter what the intrinsic value at any given moment prior to expiration, fidget prices *might rise even higher* prior to expiration. An option holder can (except in extreme market circumstances) always capture the benefits of any temporary upticks in fidget prices.

The reason such benefits can be captured is that options come in two forms, either American style or European style. "*American options* can be exercised at any time up to the expiration date. *European options* can only be exercised on the expiration date itself."[21] The difference in exercise mechanics are not for present purposes terribly significant. Suffice to say that it seldom makes sense for an option holder to exercise an option prior to expiration, because that would destroy the option's remaining time value. It is generally preferable from the holder's perspective simply to sell the option on the open market. Thus, even though European options can be exercised only on expiration, their values behave similarly to those of American options: the holder of a European option is always (absent contractual restrictions) free to sell the option at any time, regardless of whether the option is currently exercisable.

Time value of an option is, then, a function of three factors. First, it depends on the time remaining to expiration—the longer the time remaining, the greater an out of the money option's chance of moving into the money, and the greater an in-the-money option's chance of moving further into the money. Second, time value depends on the proximity of underlying fidget prices to the option's strike price. If, for example, the fidget's price just before expiration equals the strike price, any small change in the fidget price will render the option either in the money or out of the money at expiration. Similarly, if the fidget's price just prior to expiration is far out of the money, only a massive movement in underlying fidget prices will cause the option to expire in the money.

Third, time value depends on the volatility (more accurately, the anticipated or implied volatility) of underlying fidget prices. Again, the greater the volatility of—meaning the degree of fluctuations in—fidget prices, the more likely that the option will move into the money or further into the money at some time prior to expiration. Thus, in valuing an option prior to its expiration, "[t]he sole item that requires judgment is...volatility."[22] Of the three factors that determine time value, there is no doubt about the first two—the strike price and the time remaining to maturity. The only doubt relates to volatility.

An entire industry has grown out of attempts to estimate volatility accurately, because that is really the only one of the five option valuation factors over which there can be significant disagreement. For those who rely on mathematical modeling to guide their option grades, differences of opinion about option values—the differences that generate active option trading—are driven mainly by different methods of calculating volatility. Normally, one might expect the value of an option to be based on one's view of the future value of the underlying fidget. But that is not the case: "Intuitively, this implied volatility can be thought of as the combined but current judgment of the market about the *future uncertainty* of a given for-

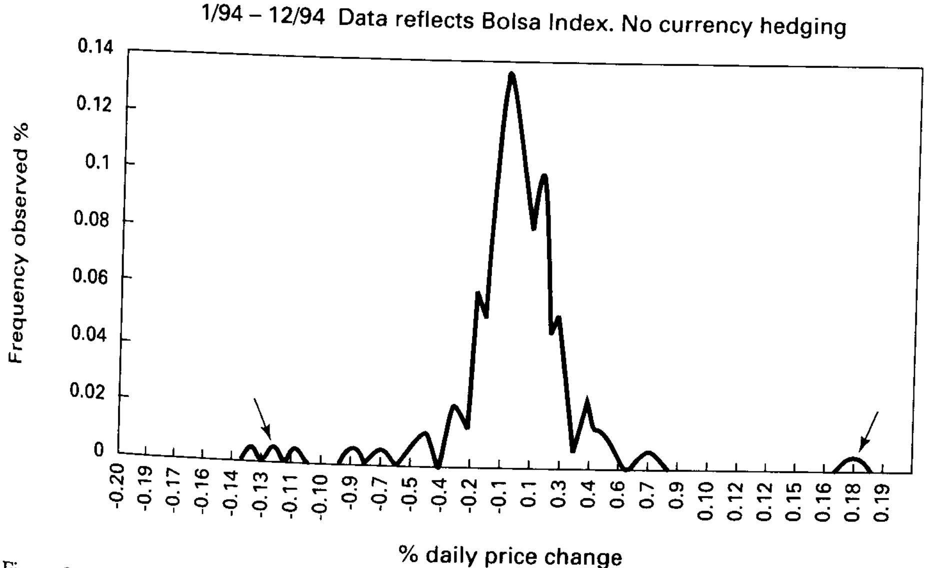


Figure 3.6 Mexican Equity Market Volatility: January to December 1994. (*Reprinted with permission from* Derivatives Risk Management, *Warren Gorham & Lamont, Boston, Mass.*)

ward price—the higher the implied volatility the more uncertain they are about the forward price."[23]

Figure 3.6 illustrates the risks involved in attempting to predict volatility. From January through November 1994, the price of equity securities in the Mexican equity market tended to fluctuate within a band of plus or minus two percentage points. However, in December 1994 the Mexican peso was devalued, leading to three separate individual daily market moves (indicated by the arrows) of greater than 10% (i.e., plus or minus 0.10).

> Based on historical analysis through November, a move of this magnitude would be regarded as virtually impossible. A more thorough analysis into the background of the sources of risk [i.e., of volatility] would have revealed that the peso exchange rate was pegged to the U.S. dollar. From this one should expect the exchange rate to typically change very little from day to day but [that] periodically [it] could change by very large amounts.[24]

As the Mexican equity market example suggests, efforts to estimate volatility can be perilous. An "incorrect" choice of the historical time horizon on which future volatility is to be estimated can result in unexpectedly large option price changes.

Although the time value of an option can be grasped intuitively without much difficulty, the mathematical computation of time value is complex and beyond the scope of this text. Likewise, it is usually beyond the scope of a senior manager's or lawyer's responsibility. Nevertheless, it is important in risk management for managers and lawyers to have a sense of the complexity that may make any derivative (or any other transaction that displays "optionality") behave counterintuitively and unexpectedly.

A sense of the complexity of an option's time value can be gained by observing that whereas the market value of a forward is plotted linearly (as is the intrinsic value of an option, with the one difference that the line changes its mathematical sign at point X in Figures 3.5 and 3.6), the value of an option, as indicated in Figure 3.7, displays curvature. The straight line at the base of the shaded region represents the option's intrinsic value. The shaded region indicates the additional value an option will have prior to expiration, because of its *time value*. As Figure 3.7 indicates, prior to expiration, the price of an option will be greater than the option's intrinsic value; in other words, the time value of an option is positive. A comparison of the lengths of lines b, c, and d in Figure 3.7 illustrates that the time value of an option varies depending on the price of the underlying fidget. When the fidget price is b', the time value will be the length of line b; when the fidget price is X, the time value will be the length of line c.

The significance of a linear plot is that the rate of change in value, and hence the *value sensitivity*, is constant: for every one dollar change in value of the fidget underlying a forward contract, the corresponding unit value of the forward contract will change by the same amount. Thus, the *rate* of change of the value of a forward is *independent* of underlying fidget prices.

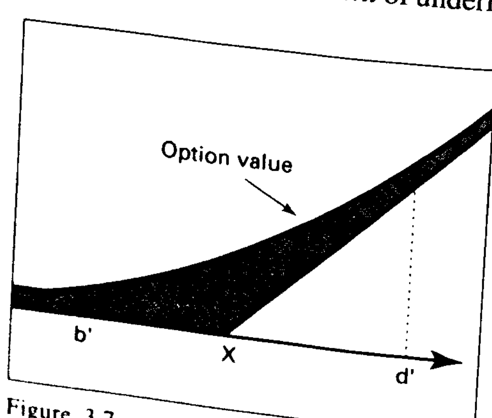


Figure 3.7 Long call option time value. (*Reprinted with permission from the Chicago Mercantile Exchange*)

In contrast, the rate of change in the value of an option is *dependent* on underlying fidget prices. Because an option's time value plot is curved, its value sensitivity depends on underlying fidget prices. Graphically, the value of a call option is indicated by the curved line in Figure 3.7. In other words, the rate of change is not constant; rather, it changes *instantaneously* upon any change in the price of the underlying fidget.* Suffice to say that the value of a deeply out of the money option will change very slowly—its rate of change approaches zero. By contrast, the value of a deeply in the money option will change at almost exactly the same rate as the rate of change in underlying fidget prices—its rate of change approaches 1.0 (or 100%). Finally, the rate of change in the of value of an option that is at the money (the underlying fidget price equals the strike price) is 0.5 (or 50%).

Thus, an option's value does not change at a constant rate. Rather, the rate of change depends on several factors, the first of which is whether the option is out of the money, at the money, or in the money. If an option is deeply out of the money and close to expiration, it will usually have some slight value. As indicated in the region in Figure 3.7 far to the left of point X, the value of the option will move to the left along the horizontal axis as fidget prices decline. The farther left it moves, the more the option value curve will converge toward the base of the shaded region, which is the line indicating that the option has a zero value. If the option is far enough out of the money, even a large movement in fidget prices is unlikely to cause the option to move into the money on the expiration date. Therefore, on a percentage basis, the change in the price of a deeply out of the money option near expiration will be close to 0% of the change in underlying fidget prices.

The reverse is also true. If an option is close to expiration and deeply in the money, its value should move in direct proportion to fidget prices. That value may not converge toward equality immediately, because prior to expiration there is always uncertainty that fidget prices will decline. But generally, in terms of Figure 3.7, the option's price will converge toward the diagonal line as fidget prices increase beyond point X. Finally, an

*The computation of an instantaneous rate of change of any quantity is calculated using a mathematically defined function, also called a *derivative*. The mathematics of the calculation of any rate of change (and of changes in the rate of change) involve differential calculus. For a useful introduction, see Salin N. Neftci, *Mathematics of Financial Derivatives* (Academic Press, 1996).

option that is exactly at the money just prior to expiration is in a highly uncertain position. A slight change in fidget prices may or may not result in the option being in or out of the money. Mathematically, the rate of value change at point X is 50%.

Caution: For risk management purposes, the resolution of both the theoretical and practical aspects of option pricing arguably remains the most challenging academic and practical problem of modern finance. The well-known Black-Scholes option pricing model has been called both "'the most important discovery ever made in financial economics,' [and] 'the most successful theory not only in finance but in all economics.'"[25] Yet, given that in practice many important assumptions on which the model depends are seldom if ever satisfied, the model is unsuitable for many practical applications.

Academics and practitioners alike are, therefore, constantly searching for alternatives to the model as well as other ways to improve on its predictive capabilities.* In sum, as we discuss in a moment:

> The non-linear price profile of options is the *first warning sign* to users that they are venturing into unfamiliar territory....[T]he curvature of options is dynamic....The landscape becomes more alien with two risks that are unique to options, *time decay* and *volatility*. Both increase or decrease the uncertainty of asset flows inherent in all options and both affect the value of an option in such a way that the *underlying asset's price need not change for the price of the option to change*....Anything with an *embedded option* also takes on the *risks of options*.[26]

FUNDAMENTAL OPTION RISKS

The sensitivity—or exposure—of an option's value to changes in fidget prices creates absolute value risk. This risk is usually expressed as a probability ranging from 0 to 1. The probability value is referred to by the Greek letter *delta*; options are said to have *delta risk*. As just demonstrated, *delta values* vary depending on where in relation to point X on the horizontal axis underlying fidget prices are located. Variation in delta is also measured and given its own Greek letter, *gamma*. Thus, options are

*See, e.g., George Yu, "Learning Curve: American Options Valuation," *Derivatives Week* (October 21, 1996): 5–6. Yu discusses three of the latest developments in the pricing and hedging of American options: the *analytical valuation method*, the *analytic method of lines*, and the *approximation by bounds method*.

also said to have *gamma risk*. The greater the non-linearity (i.e., [curvature]) the greater the [gamma] risk."[27] The relationship between delta and gamma is analogous to that between speed–the change in distance over time and acceleration–the change in speed over time.

Regardless of whether there is any change in the value of the underlying fidget prices during the life of the option, the time value of the option will eventually decay to zero. Graphically, that means that, as expiration approaches, all other things being equal, an option's price will converge toward the option's intrinsic value. Figure 3.8 depicts that result. The process by which an option's price decreases simply as a result of the passage of time is referred to as *time decay* and given its own Greek letter, *theta*. Thus, options also have *theta risk*.

Finally, arguably the most distinctive option risk is an option's volatility, or *vega risk*. "The more variable are the spot price movements of an asset, the more volatile the asset is said to be." In other words, the more uncertainty there is regarding an asset's future price, the higher its volatility. The volatility of an option is defined as "the risk of an option position changing in value as a result of the underlying asset's volatility." Volatility is critical to option pricing because it is the only one of the five primary option pricing variables (i.e., strike price, interest rate, expiration date, price of underlying, and volatility) not determined either through negotiation or by reference to some other market or rate. Volatility is determined purely by judgment, which is often based on complex mathematical models. "Viewed in this way, it is clear that the market for an

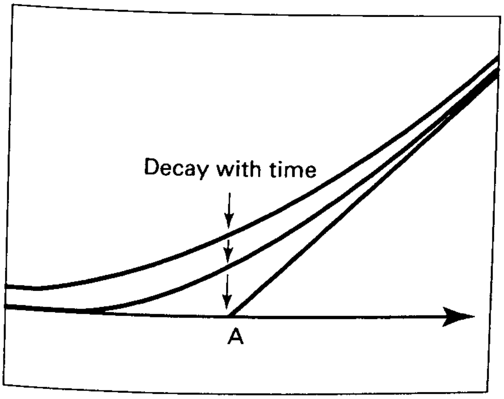


Figure 3.8 Time decay. (*Reprinted with permission from the Chicago Mercantile Exchange.*)

option on any underlying asset is in fact the market's price for the volatility on that underlying asset, quite separate from the price of the underlying asset itself. That's why some traders quote the price of an option in terms of volatility rather than the premium one has to pay."[28]

Volatility's critical role in option pricing is the primary reason that option pricing models are so important:

> Since implied volatility is the number that justifies an option price, an option buyer or seller can use that number to evaluate whether his or her option is cheap or expensive, by comparing it with the implied volatility of other options in the market. But since the number derived is dependent on the pricing model being used, different models can yield different results.…[T]he discrepancies in volatility numbers can give rise to results which are significantly different.[29]

Combined Effect

The combined effect of the "Greek letter" risks leads to a highly dynamic risk profile for individual options. Generally, the only way to perfectly eliminate option risks is by entering into an equal and opposite option contract. However, that result is seldom satisfactory because it involves the payment of an option premium, which is a guaranteed though perhaps relatively small loss. The difficulty of managing option risks is compounded by the tendency of various risks to move simultaneously yet in opposite directions. For example, as time passes, *theta* risk causes the time value of an option to decay at an accelerating rate, pushing the option value curve ever closer to the option's intrinsic value. Yet a sudden and simultaneous increase in volatility can force the option value curve in the opposite direction.

The foregoing analysis of the Greek letter risks used a call option and focused on the position of the long, or the option holder.

Caps, floors, and collars: options on interest rates

"Much as forwards can be bundled to create swaps, options can be bundled to create other option-based contracts called caps, floors, and collars."[30] Caps, floors, and collars are option-based products used to manage the risk of changes in underlying interest rates.* Each comprises a series

*Each of the three products constitutes a series of simple European, as opposed to American, interest rate options.

of options. Unbundled, each option entitles the holder to receive a portion (which may be zero) of the interest accrued (or assumed to have accrued) over an interest period on a notional amount and at a specified rate. The amount of that portion is calculated as the difference between a specified strike rate and a floating reference rate. Payments are usually made at the end of the interest period (i.e., the option's expiration date), although the reference rate used to compute the amount, if any, of each payment is the rate in effect at the start of the interest period.

A cap is a series of call options, each of which entitles the holder to receive the amount, if any, by which interest accrued on a notronal amount at the reference rate exceeds interest accrued at the strike rate. In contrast, a floor is a series of put options, each of which entitles the holder to receive the amount, if any, by which interest assumed to have accrued at the strike rate exceeded interest accrued at the reference rate. A collar is simply a combination of a cap and a floor. The "buyer" of a collar is considered to be a counterparty that has simultaneously purchased (the long position) a cap and sold (the short) a floor.

Caps, floors, and collars are usually written in relation to specific loan transactions. A buyer of a cap is usually an end user that has borrowed money at a floating rate and wishes to lock in a maximum rate it will pay on the borrowing. In contrast, a floating rate borrower that believes interest rates are unlikely to decline may agree to sell a floor. If so, it forfeits in exchange for an immediate premium at least a portion of any subsequent decline in floating rates. Finally, a floating rate borrower that wishes to cap its floating interest rate exposure without paying a premium may offset the cost of the cap premium by selling a floor. In that case, the borrower has set both an upper and a lower limit on, and thus to some extent fixed, its interest rate exposure.

Unbundling complex structures involving options

A functional approach is helpful in analyzing the risks of transactions involving embedded options as well as outright options.

Embedded option Perhaps the most common embedded option is that found in floating-rate home mortgages. Most residential floating-rate mortgage loans provide that interest rates will be reset periodically to reflect changes in some specified underlying rate. However, they also contain limits on the size of any one-period rate change and on the maximum interest rate over the life of the loan. Both the short-term and the long-term limits are considered to be options, although they are exercised automatically without need of any action on the part of the option holder—here, the borrower.

In other words, the maximum rate limit over the life of the loan represents the economic equivalent of an unbounded floating-rate loan combined with an interest rate cap. Although the cap is valuable, the purchaser of the option—here, the borrower—should not assume that the cap is free of cost. Option pricing involves the payment of a premium. A premium does not have to be stated explicitly; in the case of capped home mortgages it is instead reflected as an increase, though perhaps slight, in the applicable interest rate and effectively amortized (or paid-in installments) over the life of the loan.

Similarly, the contractual limit on short-term rate movements is economically a collar, with a notional amount that ratchets up or down on each reset date. The collar suggests two valuation questions that the homeowner may wish to consider. First, what is the cost to the buyer of the cap portion of the collar? In many cases, the premium payable by the borrower for the cap is offset by the premium for the floor that the buyer is entitled to receive. Second, is the collar properly valued? This question is complex, given that low introductory mortgage loan rates usually make it highly likely that the applicable rate will increase on each reset date, at least in the early years of the mortgage. If so, that means the floor at issuance (i.e., the date of the borrowing) is deeply out of the money to the lender, while the cap portion of the collar is in the money to the borrower. What, then, is the real cost of the in the money option to the borrower? Probably a higher mortgage interest rate.

Short straddle: transaction structure Figure 3.9 diagrams the payoff profile and time decay of a complex and fascinating transaction consummated in the mid-1980s. The transaction involved a single issuer's simultaneous sale of an equal number of three-year American put and call options on the same underlying asset, at the same strike price. The underlying asset was "one quarter of the…value of one trading unit" as of a specified date on the Nikkei 225 Index, which is a weighted-average measure of the aggregate price performance of 225 well-known stocks trading on the Tokyo Stock Exchange. The structure contemplated a dollar-denominated purchase price and dollar-denominated cash settlement value. Assume for convenience that the issuer was hedging its exposure through a strategy that involved the purchase of certain equities that were included in the index, along with certain offsetting Nikkei 225 Index options. The issuer's only obligation was to deliver yen, which would then be converted according to a preset spot exchange rate mechanism built into the documentation. Nevertheless, the options were "general contractual obligations of the [i]ssuer and…not secured by any options or futures purchased by the [i]ssuer or any form of collateral or security."

For simplicity, assume that the value of one quarter of a trading unit several weeks prior to the transaction's closing date was approximately ¥ 5000, or $150 at then spot foreign exchange rates. To facilitate the closing, that value, though it was several weeks old, was set in the offering documentation as the strike price for both the puts and the calls. The parties' intention was to adjust the put and call premiums on the closing date to reflect any changes in the value of the Nikkei 225 Index between the date at which the strike price was set and the actual closing date. Assume that by the closing date, the value of the Nikkei had fallen slightly—it had moved just to the left of point X—so that one quarter trading unit was worth approximately ¥ 4985. In contrast, assume that on the issuance date, the value of the Japanese yen had risen against the value of the dollar. Thus, the put premium at issuance was $6.50, and the call premium $9.25, with the aggregate premium received by the issuer net of transaction fees and costs exceeding $15 million.

This transaction structure, commonly called a *short straddle,* is used by an issuer when, in the words of the Chicago Mercantile Exchange (CME), "you [the issuer] expect [that the] market is stagnating. Because you are short options, you reap profits as they decay—as long as market remains near X."

The CME also includes the following caution to the option writer: "**Loss characteristics:** Loss potential open-ended in either direction.

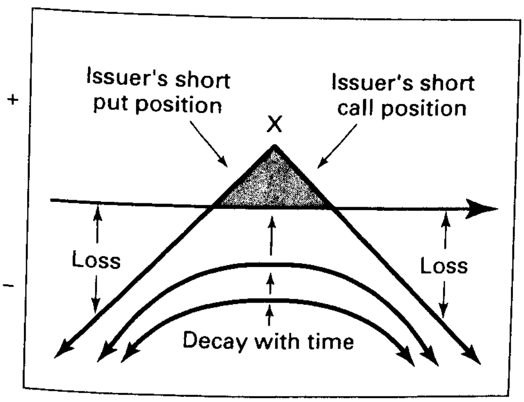


Figure 3.9 Short straddle.

Position, therefore, must be closely monitored and readjusted to neutrality if market begins to drift away from [X]." (Bold emphasis in original.) In contrast, the issuer's potential profit on the transaction, indicated by the shaded region in Figure 3.9, is limited to the net premium received, less any transaction costs incurred thereafter.

Short straddle: functional analysis The first step in a functional analysis is to unbundle the risks of the transaction. Four major risks are readily apparent: (1) the risk of changes in the value of the Nikkei 225 Index, (2) currency exchange rate risk, (3) political risk, and (4) credit risk of the issuer and any provider of credit support. For convenience, we will focus only on risks (1) and (2).

Both the long and the short positions in both options were exposed to currency exchange rate risk. All other things being equal, and since we assumed that the issuer was actively hedging its exposure in Nikkei equity securities or actual trading units on the index, any change in exchange rates would not have directly affected the issuer's obligations. Rather, a strengthening of the dollar would likely have reduced the dollar-denominated profit to an option holder, because the same number of yen would have purchased fewer dollars; likewise, a weakening of the dollar would have increased the dollar-denominated profit.

This currency risk would have been quite difficult to hedge, other than through purchases of foreign exchange options. Yet any such options would have also commanded a hefty premium. Moreover, the contingency on which the foreign exchange option would be based would not match the underlying contingency driving the value of the puts and calls. In other words, there is no necessary connection between currency exchange rate changes and changes in the value of the Nikkei 225 Index. Thus, no matter what happens with the value of the Nikkei, the currency options will have an independent value and risk structure. An equity put may expire in the money, whereas the currency option may expire out of the money. In that case, the put would be exercised but not the currency option. Conversely, the put may expire out of the money while the currency option may expire in the money. In that case, the put would not be exercised but the currency option would. Currency options here might not have provided a well-designed hedge.

In any event, of greatest interest to both the issuer and the option holders was likely the risk of changes in the value of the Nikkei Index. Both parties were exposed to price risk. But, as explained by the CME, the issuer was especially exposed to adverse price movements, because its risk was "open-ended in either direction"—that is, whether the value of the index increased or decreased. The management of price risk requires *dynamic hedging*. It is essential that the issuer monitor the delta, gamma, theta, and vega risks discussed earlier. It is useful to examine briefly the likely consequences of each risk from the issuer's perspective in light of a large market drop, such as occurred repeatedly in the late 1980s. Such an event would cause the value of the Nikkei to plummet, moving rapidly to the left along the horizontal axis of Figure 3.9.

First, *delta* (or absolute value) risk increases dramatically as the index's value moves left, and the amount by which the put grows more deeply out of the money to the issuer increases rapidly. Graphically, the put price curve would begin to approach the straight, intrinsic value line, but at an ever lower point along that line. *Gamma* risk, or the acceleration of *delta* or absolute price risk, is likely to decline rapidly as price risk approaches the solid line. That, however, cannot be adequate to counteract the effects of the *delta* risk. The effects of *theta* risk, or time decay, would depend entirely on when the market move occurs, whether near expiration or substantially prior to it.

Finally, a dramatic increase in volatility, or *vega* risk, might cause the call option to acquire a value to the holder even though it was quite far out of the money. But the greater risk to the issuer was likely with respect to the puts. Increasing volatility would have caused the entire option value curve to shift downward, increasing the degree to which the options were out of the money to the issuer.

EFFECTS OF OPTION CHARACTERISTICS ON PLAIN VANILLA TRANSACTIONS

Options are truly risky to the holder of the "short" position.* The ability of a derivatives dealer to offer optionlike features to counterparties usually implies that the dealer is offsetting the option risk by assuming somewhere else in its portfolio a corresponding long position. To cover the costs of that offset, the dealer must change its option buyer a premium.

*When options are used to speculate, they can also be risky to the holder of the "long." The reason is that the holder of the long position stands to lose the entire value of its premium paid if the option expires out of the money.

This is so even with plain vanilla products, which with minor modifications can be "enhanced" through optionlike features such as puts, or early termination rights. At least three risk management issues arise under such circumstances.

First, management must confirm that the persons responsible for designing the transaction have identified clearly the manner in which the premium is being charged. Sometimes a premium is explicit, in the form of an upfront fee. Other times, it is implicit, resulting, perhaps, in a slightly less favorable rate payable by the holder of the option. The most risky manner in which a premium is paid, as many recent derivatives fiascoes have demonstrated, is through the issuance of an offsetting option. For example, we saw in the case of a collar that a cap premium can be offset by the simultaneous sale of a floor. Although the floor may seem to be a relatively painless way of obtaining the desired cap, a floor is an option that implies option risks. Thus, the provider of the floor must consider the optionlike exposure in calculating the all-in costs of the transaction.

Second, it is equally important, after the manner in which the premium is being charged has been determined, to calculate whether the price being paid for the premium is fair.

Third, under certain circumstances, embedded option features may create legal risks, particularly when investment or transaction guidelines to which a firm or portfolio is subject specify that the organization is not to engage in "derivatives" or options transactions. The embedding of option features within other products, and the uncertainty of derivatives definitions, can create a real risk that particular products may exceed those guidelines. In that case, exposure to legal liability may arise, especially if losses are incurred and transactions are reverse-engineered to reveal their optionality only after the fact.

PUT-CALL PARITY

Options and foewards are not as different from each other as they might otherwise seem. For example, assuming equal strike prices, the diagonal segments of the intrinsic value plot of a short put (Figure 3.5) can be attached to the diagonal of a long call (Figure 3.4) for a position equivalent to a long forward (Figure 3.1). Conversely, a long put (Figure 3.4) plus a short call (Figure 3.5) is equivalent to a short forward (Figure 3.1).

This fundamental relationship also works in reverse, because "option payoff profiles can be duplicated by a dynamically adjusted combination of forwards and risk-free securities."[31] However, "dynamic-hedging" is a demanding mathematical task that summons into play the Greek letter risks just discussed. It also implies greater risks than managing forward, or linear exposures. It necessarily demands sophisticated computer facilities and skilled mathematicians. Nevertheless, the important point for present purposes is that the use of forwards (and risk-free assets) to create options, and vice versa, is possible because of a basic mathematical relationship formally called "put-call parity."

ENDNOTES: CHAPTER 3

1. Quoted in Mason et al., *Financial Engineering, supra,* Chapter 1, note 2: 43 (citation omitted).
2. Quotations in this paragraph are from Michael E. Porter, "What Is Strategy?" *Harvard Business Review* (November–December 1996) (emphasis modified) [hereafter, *What Is Strategy?*]: 61–78; see, generally, "Using Derivatives: What Senior Managers Must Know," *Harvard Business Review* (January–February 1995) [hereafter, *Using Derivatives: What Senior Managers Must Know*]: 33–41.
3. The quotations in this paragraph are from the *G-30 Overview:* 30–31; see also Charles W. Smithson, "A Building Block Approach to Financial Engineering: An Introduction to Forwards, Futures, Swaps and Options," in *SWAPS and Other Derivatives in 1997,* Kenneth M. Raisher and Alison M. Gregory, Co-chairs (Practising Law Institute, 1997): 9–22; John C. Hull, *Options, Futures, and Other Derivatives,* 3rd ed. (Prentice Hall, 1997) [hereafter, *Derivatives*]: 1–3.
4. Hull, *Derivatives, supra,* note 3: 2.
5. Saber, *Interest Rate Swaps, supra,* Chapter 2, note 9: 57.
6. See, e.g., Don M. Chance, *An Introduction to Derivatives,* 3rd ed. (The Dryden Press, 1995) [hereafter, *Introduction to Derivatives*]: 509.
7. Hull, *Derivatives, supra,* note 3: 51.
8. *G-30 Overview*: 31.
9. *Id.*: 32.
10. *Id.*
11. Miller, *The Last Twenty Years and the Next, supra,* Chapter 1, note 13: 465.
12. John F. Marshall, and Kevin Wynne, "Currency Swaps, Commodity Swaps, and Equity Swaps," *Derivatives: Tax Regulation Finance,* 2(1) (September–October 1996): 43–48.
13. *G-30 Overview*: 32.
14. Hull, *Derivatives, supra,* note 3: 8

15. *G-30 Overview*: 32.
16. Bob Reynolds, *Understanding Derivatives: What You Really Need to Know About the Wild Card of Corporate Finance* (Pitman Publishing, 1995) [hereafter, *Understanding Derivatives*]: 91.
17. Mason et al., *Financial Engineering, supra,* Chapter 1, note 2: 9.
18. See Hull, *Derivatives, supra,* note 3: 142.
19. Susan Ross Marki, *Derivative Financial Products* (HarperCollins Publishers, 1991): 34.
20. Hu, *Misunderstood Derivatives, supra,* Chapter 1, note 22: 1475.
21. Hull, *Derivatives, supra,* note 3: 5.
22. Hu, *Misunderstood Derivatives, supra,* Chapter 1, note 14: 1475; see also Hull, *Derivatives, supra,* note 3 (adding as to stock options the factor of "dividends expected during the life of the option"): 151.
23. Chew, *Leverage, supra,* Chapter 1, note 1 (emphasis in original): 158; see, generally, Hull, *Derivatives, supra,* note 3: chapter 7; Hu, *Misunderstood Derivatives, supra,* Chapter 1, note 22: 1475.
24. Dr. Saied Simozar, "Measuring Derivatives Risk," in *Derivatives Risk Management Service*, ed. G. Timothy Haight (Warren, Gorham & Lamont, 1996) [this service is hereafter referred to as *Derivatives Risk Management Service*]: ¶ 5B.04.
25. See Hu, *Misunderstood Derivatives, supra,* Chapter 1, note 22: 1475.
26. Chew, *Leverage, supra,* Chapter 1, note 1 (emphasis added): 139.
27. *G-30 Overview*: 44.
28. All quotations in this paragraph are from Chew, *Leverage, supra,* Chapter 1, note 1: 158.
29. *Id.*: 158–159.
30. *G-30 Overview*: 33; see, generally, Hull, *Derivatives, supra,* note 3: Chapters 16 and 17; Peter A. Abken, "Interest-Rate Caps, Collars, and Floors," *Economic Review* (November–December 1989) [hereafter, *Caps, Collars, and Floors*]: 2–24.
31. See Smithson et al., *Managing Financial Risk, infra,* Chapter 11, note 28: 37-44, 41.