FOR AGENDA

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September 27, 1988

To: Members of the Executive Board

From: The Secretary

Subject: Managing Financial Risks in Indebted Developing Countries - Appendices

The attached appendices on technical terms, futures and forward markets, options markets, and examples of commodity hedging provide background material to the paper on managing financial risks in indebted developing countries (SM/88/233, 9/26/88).

Mr. Mathieson (ext. 7662) or Mr. Folkerts-Landau (ext. 7665) is available to answer technical or factual questions relating to this paper prior to the Board discussion.

Att: (1)

Other Distribution:
Department Heads

INTERNATIONAL MONETARY FUND

Managing Financial Risks in Indebted Developing Countries

Supplementary Material--Appendices

Prepared by the Research Department

(In consultation with other Departments)

September 23, 1988

Table of Contents

Glossary

American Option: An option that may be exercised at any time up to and including the expiration date.

Arbitrage: Trading strategies designed to profit from price differences for the same or similar goods (asset) in different markets. Historically the term implied little or no risk in the trade, but more recently it has come to include strategies that entail some risk of loss or uncertainty about total profits. (For two arbitrage strategies in options, see Conversion and Reverse Conversion.)

Asking Price: The price at which sellers are willing to trade. This is usually accompanied by a bid, the price that buyers are willing to pay. The bid price is often a better indication of the true market level.

At-The-Money: An option is at the money when the price of the underlying instrument is very close or equal to the option's exercise price.

Basis: (1) The spread or difference between two market prices or two interest rates. In particular, the spread between a futures price and the cash price of the underlying commodity or asset; and (2) in certain other uses, "basis" is understood as a concise expression of what might more completely be expressed as "is based upon the following conditions." For example, "price basis delivered Chicago, Illinois, registered in owners's name..." means that the price being quoted is based upon those conditions being met.

Basis-Priced Contract (also Basis Quote): Offer/sale of cash commodity as a difference above or below a futures price.

Basis Risk: The risk associated with the possibility that the futures price fails to equal the relevant cash price by the time that a hedger closes out his position. Basis risk is the risk that is not eliminated by hedging in the futures market.

Bear: A trader or market analyst who feels that prices will decline.

Bid Price: The price at which buyers are willing to trade. This is usually accompanied by an ask, the price at which sellers will trade. The bid price is often a better indication of the true market level.

Black-Scholes (also Black-Scholes Model): A widely used option pricing equation developed in 1973 by Fischer Black and Myron Scholes. Used to price OTC options, value option portfolios, or evaluate option trading on exchanges (see Appendix III, pp. 39-41).

Break-Even Point: The price of the underlying instrument at which an option buyer could just recover the initial outlay or premium by exercising the option. For a call option, the break-even point is the exercise price plus the premium; a put option's break-even point is the exercise price minus the premium.

Broker: (1) A person paid a fee or commission for acting as an agent in making contracts, sales, or purchases; (2) when used as floor broker, it means a person who actually executes someone else's trading orders on the trading floor of an exchange; and (3) when used to mean account executive, it means the person who deals with customers and their orders in commission house offices.

Bull: A trader or market analyst who feels that prices will rise.

Call Option: see Options.

Carrying Charges: The costs of storing the cash commodity. These charges include the physical storage costs, insurance costs, and an opportunity cost for the interest lost on the money tied up in the commodity.

Carrying Charge Market (also Normal Market or Contango): A situation where prices are higher in the forward delivery months than in the nearby delivery months. Normally in evidence when supplies are adequate or in surplus. The price differential reflects either wholly or in part the costs of storing the commodity between the earlier and the later months.

Cash Settlement: The settlement provision on some option and futures contracts which do not require delivery of the underlying instrument. For options, the difference between the settlement price on the underlying asset and the option's exercise price is paid to the option holder at exercise. For futures contracts, the exchange establishes a settlement price on the final day of trading and all remaining open positions are marked to market at that price.

CBOE: Chicago Board of Options Exchange.

CBT (also CBOT): Chicago Board of Trade.

CFTC: The Commodity Futures Trading Commission, a U.S. federal regulatory agency which exercises control over futures market trading in the United States.

Clearing House: That branch of a futures exchange through which transactions executed on the floor are settled using a process of matching purchases and sales. A clearing organization is also charged with the

supervision of all trading accounts, the proper conduct of delivery procedures and the adequate financing of the entire operation.

CME: Chicago Mercantile Exchange.

COMEX: The Commodity Exchange. A New York exchange trading futures contracts on gold and silver and option contracts on gold futures.

Commission: The broker's fee for executing a trade. In the commodity market, commissions are round-trip, entitling the trader to buy and sell his contract. The fee is paid only once after the initial position is closed out.

Commodity Exchange: A nonprofit organization which supervises and facilitates trading activity.

Contingent Contract: Any financial instrument that entitles its holder to a payment that is conditional on the occurrence of a particular event or combination of events. For instance, an interest-rate cap entitles the purchaser to a payment whose amount depends on the level of a specified interest rate. Futures contracts, options, and other related instruments may similarly be viewed as contingent contracts.

Contract Grades: That which is deliverable on a futures contract. Basic contract grade is the one deliverable at par. There may be more than one basic grade.

Contract Month(s): The month(s) in which futures contracts may be satisfied by making or accepting a delivery.

Conversion: An arbitrage strategy in options involving the purchase of the underlying instrument offset by the establishment of a synthetic short position in options on the underlying instrument (the purchase of a put and sale of a call). The overall position is unaffected by price movements in the underlying instrument. This trade would be established when small price discrepancies open up between the long position in the underlying instrument and the synthetic short position in the options (see Arbitrage, Reverse Conversion, and Synthetic Positions).

Counterparty: The other party to a contract. For exchange-traded futures and options contracts, the counterparty is usually the exchange itself (an exception is LIFFE, where the broker plays this role). For OTC instruments, the counterparty is generally a financial intermediary such as a major money-center bank, an investment or merchant bank or a securities company.

Counterparty Risk: The risk that the other party to a contract will not fulfill the terms of the contract. This risk is avoided through the clearing house system for exchange-traded instruments; however, it is a relevant source of risk for OTC instruments such as forward agreements, interest-rate caps, floors and collars, and interest rate or currency swaps.

Cover: To close out a position previously taken, usually by buying to cover a previous short position.

Covered Writing: Generally refers to selling call options "covered" by an equal or larger long position in the security underlying the option. It is a strategy intended to augment overall returns by earning fee income on the options written against securities held for normal investment purposes.

Credit Risk: Risk associated with the possibility that the other party to a financial contract will be unwilling or unable to fulfill the terms of the contract. Credit risk is distinguished from the risks associated with changes in prices, interest rates, or exchange rates (see also Counterparty Risk).

Cross-Hedge: A hedge constructed using a hedging instrument that differs in delivery date or other characteristics from the existing exposure that is to be hedged. Cross-hedging cannot eliminate all of the risk, but is effective in risk reduction to the extent that the return on the hedging instrument is correlated with the existing cash exposure.

CSCE: The Coffee, Sugar, and Cocoa Exchange, located in New York.

Currency Swap: A transaction in which two counterparties exchange specific amounts of two different currencies at the outset and repay over time according to a predetermined schedule which reflects interest payments and possibly amortization of principal. The payment flows in currency swaps (in which payments are based on fixed interest rates in each currency) are generally like those associated with a combination of spot and forward currency transactions.

Cylinder: An options position established by writing a call option and buying a put option with a lower exercise price. Used as a hedging strategy to protect against the eventuality that the price of the underlying instrument moves outside the range between the two exercise prices.

Delivery: There are three types of delivery on futures contracts: "current"--delivery during the present month; "nearby"--delivery during the nearest active month; "distant"--delivery in a month further off.

Delivery Date: Date on which the commodity must be delivered to fulfill the terms of the contract.

Delivery Notice: The written notice given by the seller of his intention to make delivery of a commodity to settle a futures contract. This notice is passed on by the Commodity Clearing House to a buyer who must accept delivery or retainer.

Delivery Points: Locations designated by futures exchanges to which the commodity may be physically delivered.

Delivery Price: Price fixed by clearing house at which futures deliveries are invoiced. Also price at which a commodities futures contract is settled when deliveries are made.

Delta: The change in an option's price associated with a unit change in the price of the underlying instrument. An option whose price changes by $1 for every $2 change in the price of the underlying has a delta of 0.5. The delta rises toward 1.0 for options that are deep in the money, and approaches 0 for deep out of the money options (see At-the-Money, In-The-Money, Out-Of-The-Money, and Delta Hedging).

Delta Hedging: A method option writers use to hedge risk exposure of written options by purchase or sale of the underlying asset in proportion to the delta. For example, a call option writer who has sold an option with a delta of 0.5 may engage in delta hedging by purchasing an amount of the underlying instrument equal to one-half of the amount of the underlying that must be delivered upon exercise. A delta-neutral position is established when the writer strictly delta-hedges so as to leave the combined financial position in options and underlying instruments unaffected by small changes in the price of the underlying instrument.

Delta-Neutral: see Delta Hedging.

End-User: In contrast to an intermediary, a party that engages in a swap, cap, or other financial contract in order to change its interest rate or currency exposure. End-Users may be nonfinancial corporations, financial institutions, or governments.

European Option: An option which may be exercised only on the expiration date. It is an alternative to an American option, which can be exercised on any business day prior to expiration, or on the expiration date.

Exercise Price (also Strike Price): The fixed price at which an option holder has the right to buy, in the case of a call option, or to sell, in the case of a put option, the financial instrument covered by the option.

Expiration Date: (1) The date at which a European-style option may be exercised at the choice of the holder; and (2) the date before or at which an American-style option may be exercised.

Forward Contract: A cash market transaction in which two parties agree to the purchase and sale of a commodity at some future time under such conditions as the two agree. In contrast to a futures contract, the terms of a forward contract are not standardized; a forward contract is not transferable and usually can be cancelled only with the consent of the other party, which often must be obtained for consideration and other penalty. Also forward contracts are not traded on organized exchanges.

Forward Rate Agreement (FRA): An agreement between two parties wishing to protect themselves against a future movement in interest rates or exchange rates. In an interest-rate FRA, the two parties agree on an interest rate for a specified period from a specified future settlement date based on an agreed principal amount. No commitment is made by either party to lend or borrow the principal amount; their right (obligation) is only to receive (pay) the difference between the agreed and actual interest rates at settlement. Similar agreements can be made with respect to an exchange rate.

Forward-Forward Rate: A synthetic forward interest rate constructed using the term structure of interest rates. See discussion in Appendix II, p. 27.

Futures Contract: An exchange-traded contract generally calling for delivery of a specified amount of a particular grade of commodity or financial instrument at a fixed date in the future. Contracts are highly standardized and traders need only agree on the price and number of contacts traded. Traders' positions are maintained at the exchange's clearing house, which becomes a counterparty to each trade once the trade has been cleared at the end of each day's trading session. Members holding positions at the clearing house must post margin which is marked to market daily. Most trades are unwound before delivery. The interposition of the clearing house facilitates the unwinding since a trader need not find his original counterparty, but may arrange an offsetting position with any trader on the exchange (see Margin).

Gamma: The sensitivity of an option's delta to small unit changes in the price of the underlying. Some option traders attempt to construct "gamma-neutral" positions in options (long and short) such that the delta of the overall position remains unchanged for small changes in the price of the underlying instrument. Using this method, writers can produce a fairly constant delta and avoid the transactions' costs involved in purchasing and selling the underlying instrument as its price changes (see Delta).

Hedge Ratio: The proportion of one asset required to hedge against movements in the price of another. For options, the hedge ratio is the proportion of the underlying instrument needed to hedge a written option, and is determined by the delta (see Delta and Delta Hedging).

Hedging: The process of offsetting an existing risk by taking an opposite position on another risk likely to move in the same direction.

In-The-Money: An option contract is in-the-money when a net financial benefit could be derived by exercising the option immediately (in comparison to throwing it away). A call option is in-the-money when the price of the underlying instrument is above the exercise price; a put option is in-the-money when the price of the underlying instrument is below the exercise price.

Initial Margin: The funds that must be deposited to open either a long or a short position in the futures market (see Margin).

Interest Rate Cap: An option-like feature for which the buyer pays a fee or premium to obtain protection against a rise in a particular interest rate above a certain level. For example, an interest rate cap may cover a specified principal amount of a loan over a designated time period such as a calendar quarter. If the covered interest rate rises above the rate ceiling, the seller of the rate cap pays the purchaser an amount of money equal to the average rate differential times the principal amount times one-quarter.

Interest-Rate Collar: An agreement that combines the purchase of an interest-rate cap with the sale of a floor. The purchaser of a collar receives a payment if the interest rate rises above the designated ceiling, or makes a payment if it falls below the designated floor. The purchase of a collar can be used to keep a debtor's net interest cost within a pre-specified range. The premium on a collar is lower than that on a cap with the same ceiling rate, because the premium received by selling the floor is subtracted from that paid for purchasing the cap.

Interest-Rate Floor: An option-like agreement whereby the buyer pays a premium to obtain protection against a fall in a particular interest rate below a certain level. If the interest rate falls below the floor, the seller pays the purchaser an amount equal to the average rate differential times the principal amount times the designated time period.

Interest Rate Swap: A transaction in which two counterparties exchange interest payment streams of differing character based on an underlying notional principal amount. The three main types are coupon swaps (fixed rate to floating rate in the same currency), basis swaps (one floating

rate index to another floating rate index in the same currency), and cross-currency interest rate swaps (fixed rate in one currency to floating rate in another).

Intermediary: A counterparty who enters into swap, cap, forward, or other OTC contracts in order to earn fees or trading profits. Most intermediaries, or dealers, in these OTC markets are major U.S. money-center banks, major U.S. and U.K. investment and merchant banks, and major Japanese securities companies.

Intrinsic Value: The net benefit to be derived from exercising an option contract immediately. It is the difference between the price of the underlying instrument and the option's exercise price. An option generally sells for at least its intrinsic value (see also Time Value).

Inverted Market (also Backwardation): A market in which the cash market price is greater than the futures market price. The opposite of a carrying charge market.

LIBOR: London Interbank Offered Rate. The rate at which banks offer to lend funds in the London interbank market.

LIFFE: The London International Financial Futures Exchange.

Limit Price (also Maximum Price Fluctuation): Largest permitted price fluctuation in a futures contract during a trading session, as fixed by the contract market's rules.

Liquidity: The ease with which a prospective seller of a financial instrument can find a buyer at the prevailing market price. Liquidity is generally higher in markets in which there is a larger volume of trading.

Log-Normal Distribution: A normal probability distribution of a variable expressed in logarithmic form. This distribution is often used for prices of assets or commodities including the Black-Scholes model, because it implies that the price can rise to infinity but cannot fall below zero (see Normal Distribution).

Long Position: (1) In the futures market, the position of a trader on the buying side of an open futures contract; (2) in the options market, the position of a trader who has purchased an option regardless of whether it is a put or a call. A participant with a long call-option position can profit from a rise in the price of the underlying instrument while a trader with a long put option can profit from a fall in the price of the underlying instrument.

Maintenance Margin: The minimum amount which must remain in the margin account after any market losses are deducted from the initial margin. Once the account declines to the maintenance level, the broker will issue a margin call, a request that the client restore the account to its original level. Should the client refuse or default, the position may be closed out by the broker.

Margin: An amount of money deposited by both buyers and sellers for futures contracts to ensure performance of the terms of the contract, i.e., the delivery or taking of delivery of the commodity or the cancellation of the position by a subsequent offsetting trade at such price as can be attained. Margin in futures markets is not a payment of equity or down payment on the commodity itself but rather is in the nature of a performance bond or security deposit (see Initial Margin and Maintenance Margin).

Margin Call: A commodity broker's request to a client for additional funds to secure the original deposits. Margin that must be posted in response to a margin call is known as Variation Margin.

Minimum Price Fluctuation: Set by the rules of the exchange, this is the minimum unit by which the price of a commodity can fluctuate per trade.

Mirror Swap: A reverse swap written with the original counterparty.

Normal Distribution: "Bell-shaped" curve depicting a symmetric probability distribution of a continuous random variable. The distribution is defined by the mean and standard deviation, such that approximately two-thirds of all observations will fall within one standard deviation above and below the mean, about 95 percent will fall within two standard deviations above and below the mean, and so on.

Notional Principal: A hypothetical amount on which swap payments are based. The notional principal in an interest rate swap is never paid or received.

Off-Balance-Sheet Activities: Banks' business, often fee-based, that does not generally involve booking assets and taking deposits. Examples are trading of swaps, options, foreign exchange forwards, stand-by commitments, and letters of credit.

Open Interest: The total number of futures contracts of a given commodity which have not yet been offset by opposite futures transactions nor fulfilled by delivery of the commodity; the total number of open transactions. Each open transaction has a buyer and a seller, but for calculation of open interest, only one side of the contract is counted.

Open Outcry: Trading conducted by calling out bids and offers across a pit and having them accepted.

Option: The contractual right, but not the obligation, to buy or sell a specified amount of a given financial instrument at a fixed price before or at a designated future date. A call option confers on the holder the right to buy the financial instrument. A put option involves the right to sell the financial instrument.

OCC: The Options Clearing Corporation: A corporation that provides clearing facilities for all option trades on U.S. securities exchanges.

OTC Market (Over-The-Counter Market): Trading in financial instruments transacted off organized exchanges. Generally the parties must negotiate all details of the transactions, or agree to certain simplifying market conventions. In most cases, OTC market transactions are negotiated over the telephone. OTC trading includes transactions among market-makers and between market-makers and their customers. Firms mutually determine their trading partners on a bilateral basis.

Out-Of-The-Money: An option contract is out-of-the-money when there is no benefit to be delivered from exercising the option immediately. A call option is out-of-the-money when the price of the underlying instrument is below the option's exercise price. A put option is out-of-the-money when the price of the underlying instrument is above the option's exercise price.

PHLX: Philadelphia Stock Exchange.

Pit: Place where futures are traded on the floor of the commodity exchange.

Plain-Vanilla Swap: A U.S. dollar interest rate swap in which one party makes floating rate payments based on six-month LIBOR and receives fixed rate funds expressed as a spread over the rate on U.S. Treasury securities. The maturity is usually five to seven years and deal size is typically at least $50-100 million.

Position: A market commitment. For example, one who has bought futures contracts is said to have a long position, and conversely, a seller of futures contracts is said to have a short position.

Position Limit: The maximum number of speculative futures contracts one can hold as determined by the CFTC and/or the exchange upon which the contract is traded.

Premium: The price paid for an option by an option holder to the option writer.

Put Option: See Options:

Reporting Limit, Reportable Position: The number of futures contracts, as determined by the exchange and/or the CFTC, above which one must report daily to the exchange and/or the CFTC with regard to the size of one's position by commodity, by delivery month, and by purpose of the trading.

Reverse Conversion: An arbitrage trade in options involving the sale of the underlying instrument and the establishment of a synthetic long position in options on the underlying instrument (the purchase of a call and sale of a put) (see Arbitrage, Conversion, and Synthetic position).

Reverse Swap: One form of activity in the secondary swap market. A reverse swap offsets the interest rate or currency exposure on an existing swap. They can be written with the original counterparty or with a new counterparty. In either case, they are typically executed to realize capital gains.

Rollover: The replacement of one futures market position with another in the same commodity, but in a different delivery month.

Round Turn (also Round Trip): A futures contract purchase followed by an offsetting sale before delivery, or a sale followed by an offsetting purchase.

Settlement Price: The price of the financial instrument underlying the option contract at the time the contract is exercised. Where necessary, option contracts specify objective standards for determining the settlement price.

Settlement Risk: The possibility that operational difficulties interrupt delivery of funds even where the counterparty is able to perform.

Short Position: (1) In the futures market, the position of a trader on the selling side of an open futures contract; and (2) in the options market, the position of a trader who has sold or written an option regardless of whether it is a put or a call. The writer's maximum potential profit is the premium received.

Speculator: In an economic sense, one who attempts to anticipate commodity price changes and to profit through the sale and purchase or purchase and sale of commodity futures contracts or of the physical commodity; in a legal sense, any commodity futures trader not classified as a bona fide hedger by the CFTC.

Spot: Term denoting immediate delivery for cash as distinct from future delivery.

Spread: (1) A futures position established by simultaneous purchase of one commodity futures contract(s) and sale of another contract(s) in a different delivery month, in a different commodity, or traded on a different exchange; (2) an options position established by simultaneously purchasing on option and writing another with a different exercise price or expiration date. When exercise prices differ, the position is called a bull or bear spread; when expiration dates differ, a calendar spread.

Stack Hedge: A futures hedging strategy that involves taking a large position in an existing contract, and subsequently rolling over part of this position into a later contract month, possibly repeating this procedure several times. This strategy may be used to hedge risks associated with a series of payments or receipts, particularly where these are to occur at dates for which futures contracts are non-existent or illiquid (see also Strip, Liquidity).

Standard Deviation: A statistical measure of the dispersion of observations on a variable. Specifically, it is equal to:

$$\sqrt{1/n \sum_{i=1}^{n} [X_i - \bar{X}]^2}$$

where X_i are the n individual observations on a variable, $\bar{X}$ is the mean (or average) observation, and n is the total number of observations.

Straddle: An options position established by the purchase of a put and a call with the same exercise price and expiration date. This position is designed to profit from an increase in the price volatility of the underlying instrument.

Strike Price: See Exercise Price.

Strip: (1) A futures position established by taking the same (long or short) position in a futures contract for a series of delivery dates. This strategy may be used to hedge risk associated with a series of payments or receipts; (2) An options straddle position consisting of the purchase of more puts than calls although all have the same exercise date and exercise price. While the trader expects an increase in price volatility, there is also the expectation that the price of the underlying instrument is more likely to fall than to rise.

Strip Yield Curve: A synthetic yield curve implied by the structure of futures prices. See discussion in Appendix II, p. 28.

Swap: A financial transaction in which two counterparties agree to exchange streams of payments over time according to a predetermined rule. A swap is normally used to transform the market exposure associated with a loan or bond borrowing from one interest rate base (fixed term or floating rate) or currency of denomination to another (see Currency Swaps and Interest Rate Swaps).

Synthetic Positions: Combinations of options and/or the underlying instrument to produce artificially a desired risk/gain position which corresponds to that associated with another asset which may or not be directly obtainable. Some examples of synthetic positions are the following:

1. Synthetic long call: purchase put and purchase the underlying instrument;

2. Synthetic long put: purchase call and sell the underlying instrument;

3. Synthetic long position in the underlying instrument: purchase call and sell put with same strike price and same exercise date; and

4. Synthetic short position in the underlying instrument: sell call and purchase put with same strike price and exercise date.

Thin Market: A low volume market in which a large trade unduly affects the market price (see Volume, Liquidity).

Time Value: The imputed monetary value of an option reflecting the possibility that the price of the underlying instrument will move so that the option will become more valuable. The total value of an option, or its price, is comprised of its intrinsic value and its time value.

Trading Limit: The maximum number of contracts, as determined by an exchange and/or the CFTC, that one may trade in a given trading day.

Uncovered Writers (also Naked Writers): Option sellers who do not attempt to reduce their market risk by taking offsetting positions in the underlying security or other options. This strategy is also called taking a "biased" view in option writing, that is, anticipating that the option will fall in value.

Underlying Instrument: The designated financial instruments which must be delivered in completion of an option contract or a futures contract. For

example, the underlying instrument may be fixed-income securities, foreign exchange, equities, or futures contracts (in the case of futures option).

Variation Margin: Margin that must be posted in order to restore a futures account to the maintenance level (see Maintenance Margin).

Volatility: The price "variability" of the instrument underlying an option contract, and defined as the standard deviation in the logarithm of the price of the underlying instrument expressed at an annual rate. Expected volatility is a variable used in pricing options (see Standard Deviation).

Volume: The number of transactions in a financial instrument made during a specified period of time.

Voluntary Termination (Swap Market): The cancellation of a swap contract which is agreed to by both counterparties. A voluntary termination usually involves a lump-sum payment from one party to the other.

Writer (also Grantor): The party that sells an option. The writer is required to carry out the terms of the option at the choice of the holder.

Futures and Forward Markets

A futures contract is an agreement to buy or sell a specified amount of a specific commodity or financial asset at a stated price for delivery at a specified date in the future.

Commodity futures are the oldest futures contract. There is futures trading in a wide range of commodities, including barley, beef, chickens, cattle, cocoa, coconut oil, coffee, copper, cottonseed, citrus, corn, cotton, eggs, cattle, fishmeal, flaxseed, sorghum, gold, hogs, lead, lumber, mercury, oats, orange juice, palladium, platinum, palm oil, petroleum, plywood, pork, potatoes, propane, rapeseed, rubber, rye, silver, soybeans, soybean meal, soybean oil, sugar, tin, wheat, wool, and zinc. Table A1 contains a partial listing of some futures markets in which commodities of particular relevance to developing countries are traded. Table A2 provides an example of a commodity futures contract and the way in which its terms are specified. Table A3 measures the size of some important futures markets in terms of open interest and the volume of transactions (see glossary for definitions).

There are also futures markets in foreign exchange, where transactors agree to purchase or sell a pre-agreed number of units of foreign exchange at an exchange rate typically but not invariably quoted in terms of U.S. dollars. Foreign exchange futures contracts are traded in terms of a limited number of currencies, including Deutsche marks, Japanese yen, pounds sterling, French francs, Canadian dollars, Swiss francs, and Mexican pesos. Table A4 contains a partial listing of major currency futures markets and the currencies that are traded there.

Financial futures are promises to provide a particular financial asset at a predetermined price at a specified date in the future (or to pay the holder an equivalent sum of money). There are futures contracts for a number of widely-traded interest-bearing assets, including U.S. Treasury bills and bonds, Eurodollar deposits, sterling time deposits and gilts, Government National Mortgage Association (GNMA) mortgage pass-through certificates, commercial paper and Dutch, Canadian, Australian, New Zealand, Japanese, and French government issues. There is also a growing market in stock index futures, which provide the holder with a payment based on the level of a particular stock-price index such as the Standard and Poors 500 Index, the Value Line Composite Average Index or the Financial Times-SE 100 share index. Table A5 provides a partial listing of financial futures contracts traded in various centers, while Table A6 provides an example of the terms of a particular financial futures contract.

Futures contracts are traded on organized futures exchanges. The traditional practice has been to establish prices by "open outcry" in a

Table A1. Some Commodity Futures Markets Relevant to Developing Countries

Commodity	Locations of Futures Markets
I. Commodities Important as Developing-Country Exports	
Cocoa	London, New York, Paris
Coffee	Jakarta, London, New York, Paris, Sao Paolo
Copper	London, New York
Corn	Chicago
Cotton	Hong Kong, New York
Petroleum	London, New York
Rubber	Jakarta, Kuala Lumpur, Kobe, Singapore, Tokyo
Silver	Chicago, London, New York, Sydney, Tokyo, Winnipeg
Soybeans	Chicago, Hokkaido, Hong Kong, London, Tokyo
Sugar	Hong Kong, London, New York, Paris
Tin	London
Wheat	Chicago, Kansas City, London, Minneapolis, Winnipeg
II. Commodities Important as Developing-Country Imports	
Corn	Chicago
Ocean freight	Bermuda, London
Petroleum	London, New York
Soybeans	Chicago, Hokkaido, Hong Kong, London, Tokyo
Wheat	Chicago, Kansas City, London, Minneapolis, Winnipeg

Sources: John Buckley (ed.), Guide to World Commodity Markets (London: Kogan Page, 1986) and Walter C. Labys, and Peter K. Pollak (ed.), Commodity Models for Forecasting and Policy Analysis (London and Sydney: Croom Helm, 1984).

Table A2. An Example of a Futures Contract Specification

World Sugar No. 11

Contract unit	112,000 lbs. (50 long tons).
Price quotation	Cents per pound.
Minimum price fluctuation	1/100¢ per lb. or $11.20 per contract.
Maximum daily price fluctuation	1/2¢ (50 points) above or below the previous day's settlement price. Limits are expandable in increments of 1/2¢ (50 points) to a maximum of 2¢ (200 points). Limits do not apply to the nearest two months.
Trading hours	10:00 a.m. to 1:43 p.m. Trading is suspended at 1:43 p.m. and the closing call begins at 1:45 p.m. (Eastern time).
Basic grade	Raw centrifugal cane sugar based on 96 degrees average polarization.
Delivery months	Trading is permitted beginning 18 months prior to the expiration of the contract. The trading months are January (F), March (H), May (K), July (N), September (U), and October (V).
Deliverable	Argentina, Australia, Belize, Brazil, Honduras, Colombia, Costa Rica, growths Dominican Republic, El Salvador, Ecuador, Fiji Islands, French Antilles, Guatemala, India, Jamaica, Malawi, Mauritius, Mexico, Nicaragua, Peru, Republic of the Philippines, South Africa, Swaziland, Taiwan, Thailand, Trinidad, United States, and Zimbabwe.
Delivery points	A port in the country of origin or, in the case of landlocked countries, at a berth or anchorage in the customary port of export, FOB and stowed in bulk.
Delivery responsibility	Deliverer shall be responsible for all expenses pertaining to delivery and loading of sugar into the vessel, including freight taxes and other taxes of the country of origin of any nature. Normal pilotage, wharfage charges, customs fees and similar charges pertaining to the entry or exit of the vessel at loading port are for the account of the Receiver. The Receiver shall provide vessels suitable for the carriage of sugar. These vessels shall be ready to load at loading port on any day from the first calendar day of the delivery month, up to and including, the fifteenth calendar day of the second succeeding calendar month.
Speculative position limits	4,000 contracts net position in any one month. 6,000 contracts net total position.
CFTC large trader reporting level	150 contracts or more.
Last trading day	Last full business day of the month preceeding the delivery month.
Notice day	Next business day following last trading day.

Source: Coffee, Sugar and Cocoa Exchange Inc., New York, 1985.

Table A3. Some Commodity Futures Markets: Recent Size

Commodity	Contract Amount	Open Interest 1/	Volume 2/
Cocoa (CSCE)	10 tonnes	35,690	9,158
Coffee (CSCE)	37,500 lb.	23,071	3,135
Copper (CMX)	25,000 lb.	30,884	10,706
Corn (CBT)	5,000 bu.	172,867	39,351
Cotton (CTN)	50,000 lb.	31,973	6,066
Crude oil (NYM)	1,000 bbl.	167,862	49,843
Silver (CMX)	5,000 troy oz.	73,904	415,086
Soybeans (CBT)	5,000 bu.	162,790	73,546
Sugar, world (CSCE)	112,000 lb.	147,449	13,454
Wheat (CBT)	5,000 bu.	47,986	16,024
Wheat (KC)	5,000 bu.	22,614	5,487
Wheat (MPLS)	5,000 bu.	10,427	2,431
Wheat (WPG)	20 tonnes	8,541	751

Sources: John Buckley (ed.), Guide to World Commodity Markets (London: Kogan Page, 1986); and The Wall Street Journal, Thursday May 26, 1988.

1/ Open interest as of Tuesday May 24, 1988.
2/ Volume of trading, Tuesday May 24, 1988.

Notes: CSCE = Coffee, Sugar and Cocoa Exchange; CMX = Commodity Exchange; CBT = Chicago Board of Trade; CTN = New York Cotton Exchange; NYM = New York Mercantile Exchange; KC = Kansas City Board of Trade; MPLS = Minneapolis Grain Exchange; and WPG = Winnipeg Commodity Exchange.

Table A4. Some Foreign Exchange Futures Markets

Market	Currencies Traded 1/
Chicago (CME)	British pound Canadian dollar Deutsche mark ECU French franc Japanese yen Swiss franc
Chicago (MIDAM)	British pound Canadian dollar Deutsche mark Japanese yen Swiss franc
London (LIFFE)	British pound Deutsche mark Japanese yen Swiss franc
New York (FINEX)	ECU U.S. dollar index
Singapore (SIMEX)	Deutsche mark Japanese yen

Source: John Buckley (ed.), Guide to World Commodity Markets, London: Kogan Page, 1986.

Notes: In all cases, currencies listed are traded against U.S. dollars. CME = Chicago Mercantile Exchange; MIDAM = Mid America Commodity Exchange; LIFFE = London International Financial Futures Exchange; FINEX = Financial Instrument Exchange; and SIMEX = Singapore International Monetary Exchange.

Table A5. Some Interest Rate Futures Contracts

Instrument	Trading Unit	Market Where Traded
Commercial paper 30-day maturity	US$3,000,000	CBT
Commercial paper 90-day maturity	US$1,000,000	CBT
CD Three-month maturity	US$3,000,000	IMM
	£ 250,000	LIFFE
Eurodollar deposit Three-month maturity	US$1,000,000	IMM, LIFFE
GNMA CDR	US$100,000	CBT
U.S. Treasury bill Three-month maturity	US$1,000,000	IMM
U.S. Treasury bill One-year maturity	US$250,000	IMM
U.S. Treasury notes Four-six years maturity	US$100,000	CBT, IMM
U.S. Treasury bonds Fifteen years maturity	US$100,000	CBT, LIFFE
Twenty-year gilt	£ 50,000	LIFFE

Source: Torben Juul Andersen, Currency and Interest Rate Hedging, New York: New York Institute of Finance, 1987.

Notes: CBT = Chicago Board of Trade; IMM = Chicago International Monetary Market; LIFFE = London International Financial Futures Exchange; CD = certificate of deposit; GNMA = Government National Mortgage Association; and CDR = collateralized depository receipt.

Table A6. Example of a Financial Futures Contract

U.S. Treasury Notes (Chicago Board of Trade)

Deliverable Grades: U.S. Treasury notes with a face value of $100,000 and a maturity of no less than six and a half years and not more than ten years from the date of delivery.

The price at which a note with the same maturity (calculated in complete integral three-month increments to the first day of the delivery month) and the coupon rate as the issue will yield 8 percent, according to note tables prepared by the Financial Publishing Company of Boston, Massachusetts, is multiplied by the settlement price to compute the amount paid for the note principal for invoicing purposes.

Interest accrued on the notes shall be charged to the long by the short in accordance with Department of Treasury Circular 300, Subpart P.

New issues of long-term U.S. Treasury notes which satisfy the standards in this regulation shall be added to the deliverable grade as they are issued. The Financial Instruments Committee or the Board shall have the right to exclude any new issue from deliverable status or to further limit outstanding issues from deliverable status.

Delivery Months: March, June, September, and December.

Delivery: Delivery is by Federal Reserve book entry wire transfer system with invoice adjusted for coupon rates and maturity.

Price Quotations and Minimum Fluctuations: Quoted in percentage of par; e.g., 65-16 or 65-16/32, decimal equivalent = 0.655. The minimum fluctuation is 1/32 of a point ($31.25 per contract).

Daily Limits on Price Movements: Maximum fluctuation per day is 96/32 ($3,000 per contract) above or below the previous day's settlement price.

CFTC Speculative Position Limit: None.

CBT Speculative Position Limit: 5,000 contracts.

Margin requirements: Initial margin $1,500 per contract; maintenance margin $1,000 per contract; hedging margin (initial and maintenance margin required by transactor classified by the CFTC as a "bona fide hedger") $1,000 per contract.

Market Size: Volume of sales, 1985: 2,860,432
Open interest, Dec. 1985: 70,495.

Sources: John Buckley (ed.), Guide to World Commodity Markets: Physical, Futures and Options Trading (London: Kogan Page, 1986); and Chicago Board of Trade.

trading pit, a practice designed to make the market's workings public and to minimize the possibility of collusion; recently, however, there has been a tendency for pit trading to be supplanted by computerized trading. The futures exchanges also establish the form of the standardized contract and specify the procedures whereby they are traded. The goal of standardization is to ensure that the volume of trade in any one contract is large enough to provide competition among traders, as well as to promote liquidity--that is, to make it easier for any prospective seller to find a buyer, or vice versa, at the prevailing market price. Supporting a limited number of standardized futures contracts also, by limiting the number of prices in the market, makes it easier for market information to be disseminated and understood, making different contracts' prices more readily comparable.

Another distinctive feature of futures markets is the clearing house. When a futures contract has been traded, both the buyer and seller have incurred obligations: the seller has agreed to deliver the specified goods or assets and the buyer has agreed to pay a specific amount for them. Each contract is then cleared: what this typically means is that the contract is backed, not by the resources of the individual trader who initially made the contract, but by the much more extensive resources of the futures exchange itself. The exchange enforces the contract by requiring that each party deposit funds, known as margin, in order to guarantee that he will fulfill his obligation. In the event that a trader goes bankrupt, it is the exchange, rather than another trader, that incurs any losses resulting from that trader's inability to fulfill the contract; any resulting risks are limited, however, by the posting of margin. In addition, since the exchange maintains an equal number of contracts long and short--that is, for each contract cleared, the exchange incurs an equal and opposite obligation to buyer and seller--the exchange is not exposed to risk from fluctuations in the price of a contract. The clearing-house system facilitates trading in futures contracts by making them anonymous: there is no need to assess the credit-worthiness of another individual trader before buying or selling a futures contract.

An exception to the typical operation of the exchange clearing-house system is the London International Financial Futures Exchange (LIFFE). On LIFFE, the broker-member clears the transactions of his clients and acts as counterparty for all their contracts; the individual trader's legal relationship is with his broker, rather than with the Exchange. The overall position of the broker is established by netting out the long and short positions of all his clients; the broker's net position, in turn, is cleared by the Exchange.

Another important feature of futures markets is the practice of marking to market. When a transactor undertakes a futures contract, he is required to post initial margin, a sum of money required to guarantee

fulfillment of the contract. Initial margin is generally on the order of 2-3 percent of the face value of the contract. However, once a contract has been made at the prevailing market price, any subsequent changes in the market price of the same futures contract will affect the trader's position: for example, someone who has a long position makes money if the futures price rises and loses money if it falls. "Marking to market" means that, at the end of every day, any gains are added to a trader's accounts and any losses are subtracted. In case of losses, a trader is required to put up more money to cover these losses, in order to preserve the value of his position at some minimum level (called maintenance margin). This requirement that the trader experiencing losses post additional margin, permits a cash payment to the trader's counterparty who is experiencing a gain.

In order to ensure orderly trading and to limit the gains and losses that can be incurred in a single day--and thereby to limit the risk of bankruptcy faced by the futures exchange itself--limits are generally imposed on daily price movements. Once the price of a futures contract reaches its limit, trading is stopped.

Forward contracts, like futures contracts, are agreements to buy or sell a specified amount of a specified commodity or asset at a specified location and date for a specified price. The difference between forward and futures contracts is that forward contracts are not traded in organized exchanges but are offered, typically by banks, on an over-the-counter (OTC) basis. An individual or firm wishing to undertake a forward contract will approach a bank (typically by telephone) in order to obtain a quotation. Because forward contracts are traded on a decentralized basis rather than on an organized exchange and are priced individually rather than by open outcry, they are much more flexible: they can be tailored to the needs of individual transactors. In addition, forward contracts are traded in many more locations in different time zones: this permits forward trading to continue almost around the clock, whereas futures trading can only take place while the market is actually open. On the other hand, forward trading lacks the anonymity provided by the clearing-house system: a forward contract entails a risk that the other party (the counterparty) will be unable to fulfill the contract. This counterparty risk limits the liquidity of forward contracts, and excludes from the market all but highly credit-worthy transactors.

Forward contracts in foreign exchange are of considerable importance, and can be made in terms of any of a large number of pairs of currencies. Forward rate agreements on interest rates are another important financial instrument, which enable the purchaser to lock into a pre-agreed interest rate at a specified date in the future: if, at that date, the market interest rate turns out to exceed the rate specified in the forward rate agreement, the seller of the contract must pay the buyer

the difference (multiplied by the face value of the contract); if the prevailing market rate falls short of the rate specified in the contract, the buyer pays the seller the difference.

Futures and forward contracts also differ in terms of the degree of basis risk. The basis is the difference between the price of a futures contract and the price of the underlying cash instrument. The basis approaches zero as the date specified in the futures contract approaches; this is known as convergence. However, if futures contracts are being used for hedging purposes, the cash instrument against movements in whose price the hedge is being constructed may be different from that which underlies the futures contract. There are three important differences to consider: one is that the settlement date for the futures contract may be different from the date on which the individual's cash commitment arises. A second is that the commodity or asset specified in the futures contract may be different from the one to which the cash commitment pertains. A third is that (especially in the case of commodities) the location specified in the futures contract may differ from the one that is relevant to the individual. To the extent that any of these differences exist, the individual is said to engage in cross-hedging. Cross-hedging involves a basis that does not necessarily converge to zero by the relevant date. To the extent that movements in the basis may be unpredictable, the hedger faces basis risk. Basis risk cannot in general be eliminated by hedging using existing futures contracts. Notwithstanding the existence of basis risk, cross-hedging is useful in reducing risk to the extent that movements in futures prices are correlated with the spot price movements against which an individual wishes to hedge.

Cross-hedging can be illustrated using the following example. Consider a country with floating-rate external debt on which the interest rate is reset annually, indexed to the 12-month LIBOR. In the absence of a 12-month LIBOR futures contract, the authorities would have to cross-hedge using contracts on some other interest rate. In choosing the appropriate instrument for cross-hedging out of the set of interest rates for which futures contracts exist, they would try to find an interest rate whose movements are closely correlated with those of the 12-month LIBOR. If they wish to hedge a large amount of debt, they would also have to choose a contract in which the volume of trading activity is sufficient to create a high degree of liquidity, so that the market can absorb the proposed hedging operation without affecting the contract's price. (In practice, in view of both risk and liquidity considerations, it is often preferable to construct a hedge combining positions in more than one contract, rather than being limited to a single contract.)

Once the appropriate hedging instrument (the three-month Eurodollar contract, for instance) has been chosen, the number of futures contracts needed to produce the desired hedge must be determined. Suppose that the

three-month Eurodollar futures interest rate is equal to the Eurodollar rate that is expected to prevail at the contract's settlement date (see page 28 below). If we make this assumption and if we ignore the transactions costs of hedging, the optimal hedge is simply one that minimizes the hedger's risk (otherwise, there is a tradeoff between risk and the expected cost of hedging--see page 31 below--whose outcome depends upon the hedger's degree of risk aversion). In this case, the appropriate number of contracts is the product of several factors:

$$N = (F_1/F_2) \times \beta \times \delta \times \psi$$

where N is the number of contracts required, F_1 the face value of the debt to be hedged and F_2 the face value of each futures contract ($1 million in the case of the three-month Eurodollar contract). Here, β is the regression coefficient of the interest rate of the hedging instrument on the interest rate to be hedged; the regression coefficient is a measure of the statistical relationship between the two interest rates, which reflects both the closeness and the magnitude of the relationship; in the example, a regression coefficient of $\beta = 0.5$ indicates that a 1 percentage point increase in the three-month Eurodollar rate is, on average, associated with a 1/2 percentage point increase in the 12-month LIBOR. The duration factor, δ, reflects the fact that if the desired maturity of the hedge is longer than that of the hedging instrument, more futures contracts will be needed in order to achieve the desired coverage. The present value factor, ψ, reflects considerations regarding the financing of the cash flows associated with futures contracts: since futures contracts are marked to market daily, the gains or losses on these contracts accrue before the interest payments on the external debt are due. Hence, any gains realized on the futures position can be invested until the date at which debt interest is paid; likewise, any losses will have to be financed until that date. It is therefore important to take account of the timing of cash flows by including the present value factor in determining the appropriate number of contracts with which to hedge.

The discussion in the previous paragraph indicates how one could select the optimal hedge ratio, the optimal ratio of the face value of the hedge to that of the hedger's existing exposure. With simple hedging--that is, when there is a hedging instrument that corresponds exactly to the prospective hedger's existing exposure--the optimal hedge ratio is one. In this case, all the risk can be eliminated. With cross-hedging, however, the optimal hedge ratio, as determined by the formula presented in the previous paragraph, may be either greater or less than one. Even when a cross-hedge is constructed optimally, however, it is necessarily an imperfect hedge: it is never possible to eliminate all of the risk. The remaining risk, which cannot be eliminated by cross-hedging, is in the nature of basis risk.

Basis risk is the disadvantage of the standardization provided by exchange-traded futures. In forward markets and other OTC markets, it is possible, at least in principle, to construct a perfect hedge, since the contract can be tailored to the transactor in terms of settlement date, location and other specifications. For instance, forward contracts are available for distant dates in the future, for exchange of "exotic" currencies that are not traded on the organized futures markets and for interest rates other than the commonly used ones. This flexibility makes it possible for the individual transactor to avoid all basis risk. There may be a cost to this flexibility, however: if a financial intermediary issues a standard forward contract, it can easily eliminate its own resulting risk exposure by issuing a similar but opposite contract to another customer, or by hedging through transactions in organized futures markets or in other financial markets. If the intermediary issues an unusual contract designed to eliminate basis risk for a particular customer, it may be more difficult for it to hedge its risk through either of these methods. The basis risk which is thereby transferred to the intermediary may nevertheless be reduced or eliminated through diversification; the extent to which this is possible depends in each case on the extent to which the basis is correlated with the other risks to which the intermediary is subject. If, by tailoring a forward contract to an individual customer, the intermediary has to incur some risk that cannot be diversified away, it will have to be compensated for this risk, and this will increase the customer's cost of hedging.

Transactions costs figure differently in exchange-traded futures contracts and in forward contracts. With futures contracts, trade is generally executed by brokers who charge a commission for their service. Commissions are charged on a round-turn basis, that is a single commission for buying a futures contract and then selling it again. The commission is due when the position is finally closed out. On the other hand, in the OTC markets, transactions costs are incorporated into the spread between the bid and ask prices quoted by investment banks.

The final element that is important in assessing the costs of hedging using the futures markets is the determination of futures prices. The futures price of a commodity or asset will in general differ from the spot price that will materialize at the settlement date. However, there are two mechanisms that create a link between the futures price and the spot price. The first of these is the possibility of hedged storage for some commodities: if the currently-prevailing spot price plus the cost of storing the good until the settlement date is less than the futures price, a firm could risklessly store the good, sell the futures contract and make delivery, taking advantage of this difference; this is known as intertemporal arbitrage. Such behavior tends to drive down the futures price and drive up the spot price until the two differ only by the cost of storage. The resulting price structure, with futures prices exceeding

spot prices, is known as a carrying charge market, or contango. If futures prices are not high enough relative to spot prices to provide an incentive for storage, stocks of the commodity will be depleted, tending to drive down the spot price and drive up the futures price; if the elimination of all stocks of the commodity is not enough to restore a carrying charge market, there is said to be an inverted market (or backwardation).

This discussion of storage has been framed in terms of commodities, but it can be extended to financial assets. In particular, in the foreign exchange market the analogue is the possibility of covered interest arbitrage. The cost of "storing" a foreign currency is the difference between the interest rate that can be earned on assets denominated in the foreign currency and the equivalent domestic rate; if this interest differential (which can of course be either positive or negative) were less than the futures premium--the difference between the spot and futures exchange rates--there would be a riskless opportunity for profit by selling domestic-currency assets, buying foreign currency spot, buying foreign assets and selling foreign currency in the futures market. The argument is symmetric if the premium is less than the interest differential. This mechanism generally brings about covered interest parity (aside from transactions costs).

The same principles apply to interest-rate futures, but in a slightly more complicated way. For interest-rate futures, one form of intertemporal arbitrage is to purchase a financial asset and sell a futures contract on that asset; the asset can then be delivered in fulfillment of the futures contract. Such intertemporal arbitrage is profitable if the futures price exceeds the cash price by more than the cost of carrying the asset. The relevant carrying cost (which may be either positive or negative) is the interest cost of borrowing to finance the purchase of the financial asset, net of any return obtained by holding the asset until the delivery date specified in the futures contract. The possibility of interest arbitrage creates a tendency for cash and futures prices to differ only by the amount of these carrying costs.

Another way of characterizing the arbitrage relationship between a futures price and the cash price of the underlying asset involves the term structure of interest rates. Consider, first, a simple example. An investor can lend for six months in either of two ways: (1) buying six-month Treasury bills and holding to maturity or (2) buying three-month T-bills and buying a futures contract on three-month T-bills for delivery in three months' time, taking delivery on the futures contract and holding the delivered bills to maturity. Strategy (2) can be characterized as one of establishing a synthetic position that mimics the position established

by strategy (1). This synthetic position implies a six-month yield which is equal to

$$2\{(1 + r_3/4)[1 + (100 - P_3)/4] - 1\}$$

where r_3 is the three-month yield and P_3 the futures price of a three-month bill for delivery in three months' time. Following similar reasoning, the futures prices of the three-month instrument for other, more distant delivery dates can be used to construct synthetic yields for nine, twelve and fifteen-month maturities. If these synthetic rates, implied by the current three-month rate and the structure of futures prices for the three-month instrument, are graphed against the corresponding maturities, the result is a synthetic yield curve, known as a strip yield curve. If the strip yield curve differs from the ordinary cash-market yield curve, there is an opportunity for arbitrage--which can be viewed, for instance, as borrowing at the six-month rate to finance the synthetic position described. Such arbitrage is riskless, and thus tends to bring together the strip yield curve and the cash market yield curve. Discrepancies between the two yield curves are typically explained by transactions costs, liquidity considerations, regulatory constraints inhibiting arbitrage by institutional investors and risks of being unable to maintain the futures half of an arbitrage position due to the practice of marking to market.

Yet another equivalent way of viewing arbitrage in financial futures is derived from the observation that one can use the term structure of interest rates to construct a synthetic futures position. Consider, for instance, the following two alternative ways of obtaining a three-month T-bill in three months' time: (1) buy a futures contract for a three-month T-bill with a delivery date in three months' time, and take delivery on the contract or (2) buy a six-month T-bill now while selling a three-month bill short (i.e., borrowing at the three-month rate), buying it back (repaying the loan) at its maturity date (at which time the six-month bill originally purchased has a remaining maturity of only three months). The position constructed through strategy (2) mimics that established in strategy (1) and can thus be characterized as a synthetic futures position. The cost of acquiring a T-bill through this synthetic position implies a synthetic futures rate, which is known as the forward-forward rate; in this example, it is

$$4\{(1 + r_6/2)/(1 + r_3/4) - 1\}.$$

Arbitrage tends to bring the futures rate and the forward-forward rate into equality with each other, although they may differ for the same reasons that cash and strip yield curves may differ.

The second mechanism that establishes a relationship between spot and futures prices is the possibility of speculation. Speculators in the futures market attempt to forecast the spot price that will prevail at the settlement date; if the futures price is less than their forecast of the spot price, they would expect to be able to profit by buying in the futures market, planning to sell at the spot price prevailing at the settlement date. This behavior by speculators tends to drive the futures price up toward equality with forecasts of the spot price. The argument is symmetric: if futures prices exceed predicted spot prices, speculators would sell in the futures market (taking a short position), and this behavior would tend to drive the futures price down toward equality with the predicted spot price. This behavior by speculators is risky: speculators can incur losses if their forecasts are incorrect. For this reason, it has been suggested that speculators may only operate if they expect to receive a risk premium, that is some minimum reward for incurring this risk. This would limit the tendency for futures prices to be brought to equality with predicted spot prices. However, there is no particular reason to believe that a risk premium should bias futures prices in one direction rather than another: speculators must fill the gap between hedgers on the long and the short sides of the market. As a first approximation, if there is more short hedging interest than long, the futures price must be less than the expected spot price, in order to provide risk-averse speculators with an inducement to take long positions; the reverse is true, however, if there is more long hedging interest than short. In a more careful analysis, the bias in futures prices would also depend on the correlation between the unanticipated component of the spot price and the returns on the rest of the typical speculator's portfolio. The bias could be either positive or negative.

The discussion of futures prices can be summarized as follows: the possibility of intertemporal arbitrage implies that the futures premium on a storable commodity or asset will be no more than the marginal cost of storage. The possibility of speculation implies that the futures price will differ from speculators' forecast of the spot price by no more than a premium required to induce the speculators to bear the risk associated with taking a position in the market. Both of these tendencies limit the cost of hedging: if futures prices equal predicted spot prices, the cost of hedging is simply the commission that must be paid for buying or selling futures contracts.

In Table A7, some recent examples of futures prices are presented. For instance, at the close of trading on May 25, one could purchase 112,000 pounds of sugar for October delivery at a price of $0.0928 per pound, making the total cost of one contract $10,393.60. The price of the October 1988 contract has fluctuated, since the contract was first issued, between a high of $0.1035 per pound and a low of $0.07 per pound. Contracts for more distant months generally carry slightly higher prices,

Table A7. Some Examples of Futures Prices

(Data for Wednesday, May 25, 1988)

Sugar--World (CSCE)
112,000 pounds; cents per pound

Delivery Months	Daily Close	Lifetime High	Lifetime Low	Open Interest
July	9.22	10.38	6.79	29,404
October	9.28	10.35	7.00	67,944
March 1989	9.27	10.32	7.66	45,699
May	9.28	10.20	7.87	4,028
July	9.34	9.70	8.10	357

Volume 11,682; open interest 147,449

West German deutsche mark (IMM)
(125,000 marks; $ per deutsche mark)

June	0.5873	0.6494	0.5410	49,993
September	0.5934	0.6555	0.5609	9,482
December	0.5994	0.6610	0.5705	1.563

Volume 19,356; open interest 61,043

Eurodollar (IMM)
($1 million; pts. of 100 percent)

Delivery Months	Daily Close	Implied Yield	Lifetime High	Lifetime Low	Open Interest
June	92.33	7.67	92.38	92.32	112,574
September	91.79	8.21	91.85	91.76	128,388
December	91.46	8.54	91.51	91.45	55,904
March 1989	91.25	8.75	91.31	91.24	36,687
June	91.07	8.93	91.13	91.08	17,617
September	90.92	9.08	90.97	90.91	15,464
December	90.79	9.21	90.82	90.78	11,982
March 1990	90.67	9.33	90.72	90.67	15,217
June	90.56	9.44	90.61	90.57	12,077
September	90.46	9.54	90.52	90.47	9,788
December	90.36	9.64	90.42	90.37	9,167
March 1991	90.26	9.74	90.32	90.27	4,898

Volume 76,424; open interest 429,763

Source: The Wall Street Journal, Thursday, May 26, 1988.

presumably reflecting carrying charges. Open interest is highest in the October contract; in the July contract it is lower, suggesting that by late May many traders had closed out their July positions. Open interest is also lower in the more distant months. The volume of trading was 11,682, about 88 percent of the outstanding contracts.

In late May, one could purchase deutsche marks for December delivery for $0.5994 per mark (on May 25 the spot mark was $0.5882). The rates increase as the delivery date becomes more distant, reflecting carrying charges (lower German than U.S. interest rates), expectations that the mark would rise vis-a-vis the dollar or some combination of the above.

The Eurodollar futures market displays a much wider range of delivery months--up until March 1991. The price quoted for a Eurodollar deposit is 100 percent minus the interest rate. For instance, one could purchase a Eurodollar deposit for June 1989 delivery for 91.07, implying that one must pay $910,700 for a deposit whose face value at maturity is $1 million; this implies that the purchaser could lock in a yield of 8.93 percent from June until September 1989. Eurodollar futures prices fall as one moves to more distant delivery dates; equivalently, yields rise as the delivery date becomes more distant. This is the typical situation in the interest rate futures market, corresponding to an upward-sloping yield curve; the structure of futures prices shown in the table indicates that the strip yield curve is also upward-sloping.

In conclusion, the costs of hedging using the futures market have three elements. First one must consider the present value of the gains or losses incurred through changes in the futures price between the date at which the futures position is opened and when it is closed. If speculators are active in the market, these gains and losses should be zero on average. The trader experiences these gains or losses as prices change each day: his account is marked to market and he is required to post variation margin in order to maintain his position. A second element is the present value of the commission that must be paid to a broker in order to undertake the purchase and sale of the futures contract. As commissions are charged on a round-trip basis, commission need not be paid until the hedger's position is closed out. Finally, the impact on the hedger's cash flow of margin requirements can influence the overall cost of hedging. Initial margin is refundable and interest is paid on it, while variation margin reflects the gains or losses that are incurred daily as the contract's price changes; neither of these margin requirements is therefore, in itself, an additional cost to the hedger, as they are already included in the expected present value of gains and losses associated with the futures position. Both, however, affect his cash flow. A hedger with unlimited access to financial markets would care only about the net present value of his outlays and receipts, and would only care about the timing of each to the extent that this affects the net

present value; cash flow can be a significant issue, however, for a hedger whose access to financial markets is limited by credit-worthiness considerations. Hedging means undertaking a risk to cancel out another pre-existing risk: thus any losses associated with the hedger's futures position are offset by gains associated with the pre-existing risk, and vice versa. If these gains and losses are incurred at different times, however, the hedger may need to have funds available to cover some losses, while the offsetting gains will only be realized later.

Options Markets

An option gives the holder the right, but not the obligation, to buy or sell a good or financial asset at a specified price (called the exercise price or strike price) at or until a particular date (the expiration date). A call option gives the holder the right to buy a particular good or asset, while a put option gives the holder the right to sell. To obtain this right, the holder of the option pays a premium, which is given to the issuer of the option irrespective of whether or not the option is exercised.

An option is purchased in anticipation that it may be advantageous to exercise the option--to carry out the purchase or sale to which the holder of the option is entitled--at or before the option's expiration date. The purchaser need not actually exercise the option in order to capture this potential benefit: he could also re-sell the option, and the potential benefit of exercising the option is reflected in the market price. An American option may be exercised at any time until it expires, while a European option may only be exercised at its expiration date. A call option is worth exercising at its expiration date if the market price of the good or asset exceeds the exercise price specified in the option contract; a put option is exercised at its expiration date if the market price is less than the strike price. If at any time an option would be worth exercising rather than throwing it away, it is said to be in-the-money; for a call option, this occurs when the price of the underlying instrument exceeds the exercise price; a put option is in-the-money if the exercise price exceeds the price of the underlying instrument. If an option is not in the money, it is said to be out-of-the-money or (if the exercise price is just equal to the price of the underlying instrument) at-the-money.

Because the option gives the holder the right but not the obligation to trade, it offers an asymmetrical risk/reward profile. The holder's gains are greater, the deeper in-the-money the option turns out to be at the expiration date, with a call option, potential gains are thus unlimited. The holder's potential losses, on the other hand, are limited to the option premium paid.

A person who sells an option (the option writer) does so in order to earn the option premium, in the hope that the option will stay out-of-the-money and expire worthless (or at least will not go deep enough into-the-money to offset the premium received). An option writer faces the risk that the option will be exercised. A common practice known as covered writing is to hedge against this risk by taking an offsetting position in the underlying asset--hedging a call option, for example, by holding securities that can be delivered if the call is exercised. Writing an

option without hedging, known as uncovered or naked option writing, involves substantial, sometimes unlimited risk; only highly credit-worthy individuals and institutions are permitted to engage in this activity.

There are widely-traded options on a variety of financial assets, including interest-bearing assets and foreign currencies as well as stocks and stock indices. Futures options, options to buy or sell futures contracts in commodities or financial assets, are also widely traded. There are also options to buy or sell commodities directly, but these are less common on organized markets. There are both options and futures options in foreign currencies. Table A8 presents a partial list of futures options on commodities, and the major markets in which they are traded. Table A9 lists some foreign exchange options and futures options. Table A10 lists some of the markets in which options on interest-bearing assets are traded.

Another important distinction is that between exchange-traded and over-the-counter (OTC) options. Exchange-traded options have the advantage of standardization of contract form, strike prices and expiration dates as well as trading procedures; this standardization brings with it the benefits of liquidity, competition in price-setting, and ready availability and interpretability of information (as discussed in connection with futures markets above). Options exchanges also establish a clearing procedure: once an option has been cleared, it becomes the obligation of the options exchange rather than of the individual who initially issued the option. If the holder of an exchange-traded option chooses to exercise it, there is a randomized procedure for assigning the option, that is for determining which of the issuers of like options is required to fulfill the option's terms.

As against the advantages of the standardization provided by exchange-traded options, OTC options can be tailored to the needs of the individual hedger. As has been discussed in connection with futures and forward markets, standardization involves basis risk, to the extent that the price movements against which someone is trying to hedge may be imperfectly correlated with the price that is specified in the option contract. However, avoiding this basis risk by obtaining a customized contract in the OTC market may have a cost: an intermediary writing an option contract generally tries to offset the resulting risk by hedging in the organized options markets or in the market for an underlying asset, but basis risk cannot be eliminated in this way. To the extent that the basis risk is nondiversifiable, i.e., to the extent that it is correlated with the other risks to which the intermediary is subject, the intermediary will have to be compensated for bearing this risk, and this will add to the cost of hedging.

Table A8. Some Commodity Futures Options Markets

Commodity	Contract Amount	Open Interest 1/
Cocoa (CSCE)	10 tonnes	5,136 calls, 2,605 puts
Coffee (CSCE)	37,500 pounds	4,964 calls, 2,994 puts
Copper (CMX)	25,000 pounds	10,022 calls, 5,148 puts
Corn (CBT)	5,000 bu.	40,107 calls, 30,752 puts
Cotton (CTN)	50,000 pounds	7,873 calls, 2,983 puts
Crude oil (NYM)	1,000 bbl.	87,394 calls, 94,272 puts
Silver (CMX)	5,000 troy ounces	2,808 calls, 12,713 puts
Soybeans (CBT)	5,000 bu.	88,789 calls, 52,495 puts
Sugar (CSCE)	112,000 pounds	60,691 calls, 18,345 puts
Wheat (CBT)	5,000 bu.	9,301 calls, 9,197 puts
Wheat (KC)	5,000 bu.	2,090 calls, 1,169 puts

Sources: John Buckley, Guide to World Commodity Markets (ed.), London: Kogan Page, 1986; and The Wall Street Journal, Thursday, May 26, 1988.

1/ Open interest as of Tuesday, May 24, 1988.

Notes: CSCE = Coffee, Sugar, and Cocoa Exchange; CMX = Commodity Exchange; CBT = Chicago Board of Trade; CTN = New York Cotton Exchange, NYM = New York Mercantile Exchange; and KC = Kansas City Board of Trade.

Table A9. Some Foreign Exchange Options and Futures Options

Currency	Trading Unit	Exchange Where Traded
Canadian dollar	Cdn$50,000	ME, PHLX
	Cdn$100,000	CME
Dutch guilder	US$10,000	EOE
ECU	US$10,000	EOE
French franc	FF 250,000	PHLX
German mark	DM 50,000	LIFFE
	DM 62,500	PHLX
	DM 100,000	ME
	DM 125,000	CME, LIFFE
Japanese yen	¥ 6,250,000	PHLX
	¥ 12,500,000	CME, LIFFE
	US$100,000	ME
Swiss franc	SF 125,000	CME, LIFFE
	US$62,500	PHLX
	US$100,000	ME
Pound sterling	£ 10,000	EOE
	£ 12,500	PHLX
	£ 25,000	CME, LIFFE
	£ 100,000	ME

Source: Torben Juul Andersen, Currency and Interest-Rate Hedging, New York: New York Institute of Finance, 1987.

Note: CME = Chicago Mercantile Exchange; EOE = European Options Exchange, Amsterdam; LIFFE = London International Financial Futures Exchange; ME = Montreal Exchange; and PHLX = Philadelphia Stock Exchange.

Table A10. Some Interest-Rate Options

Underlying Instrument	Trading Unit	Exchange Where Traded
Three-month Eurodollar	US$100,000	LIFFE
U.S. Treasury notes	US$100,000	CBT
U.S. Treasury bonds	US$100,000	CBOE, CBT, LIFFE
U.K. long gilt	£ 50,000	LIFFE

Source: Torben Juul Andersen, Currency and Interest-Rate Hedging, New York: New York Institute of Finance, 1987.

Notes: CBT = Chicago Board of Trade; CBOE = Chicago Board Options Exchange; and LIFFE = London International Financial Futures Exchange.

One kind of over-the-counter option that is of particular relevance is an interest-rate cap or floor agreement. An interest-rate cap is essentially a put option on an underlying financial asset: when the interest-rate rises above a specified level, implying that the asset price falls below the strike price, the option can be exercised, enabling the holder to sell the asset at the strike price (i.e., borrow at the ceiling rate of interest). In this way, an interest-rate cap can impose a maximum on the interest-rate that a borrower must pay; in return, the borrower must pay a premium. An interest rate floor agreement is equivalent to a call option on the underlying asset, written by the borrower: if the specified interest-rate falls below the floor, so that the price of the underlying asset rises above the strike price, the call is exercised, enabling the purchaser to buy the asset at the strike price (i.e., lend at the floor rate of interest). This option therefore places a minimum on the interest-rate that the borrower must pay; in return, the borrower receives a premium.

The customer's credit worthiness is of asymmetrical importance to a cap and to a floor: buying a cap is equivalent to buying a put option and the premium is paid "up front;" this requires that the customer have the money to pay the premium, but, once it is paid, the customer's credit worthiness is not an issue. Selling a floor, on the other hand, is equivalent to writing a call option: in some sense, for the debtor, the call is hedged, since the payments made in case the option is exercised are offset by the lower interest rate on the customer's original loan; should the customer default on the original loan, however, this hedge breaks down and the floor agreement becomes equivalent to naked call writing--an activity with potentially unlimited risk.

Combining a cap and a floor results in a collar agreement, which keeps the borrower's interest cost within pre-specified bounds: it is equivalent to what in exchange-traded options markets is known as a cylinder, i.e., a combination of buying a put option and writing a call option. A collar agreement is less expensive than a cap by itself, because the premium received on the floor agreement is set against the premium paid on the cap; in fact, a collar, like a cylinder, can, if desired, be constructed in such a way as to make its net premium cost zero. However, since one ingredient of a collar is a floor agreement, and a floor can only be made by a credit worthy customer, a collar agreement is also available only to the credit worthy.

The major element in the cost of using the options market is the options premium. An options premium is determined as the price of an option in a competitive market, and thus depends on the option's value to a prospective buyer. This value has two components: the intrinsic value is the value of being able to exercise the option immediately, that is the difference between the strike price and the market price of the good or

asset to which the option applies, multiplied by the number of units that the option entitles the holder to buy or sell. The intrinsic value of an in-the-money option is positive, while that of an at-the-money or out-of-the-money option is zero. In addition to the intrinsic value, an option also has a time value: the time value reflects the possibility that, over the option's remaining life, it may go even deeper into the money (or an out-of-the-money or at-the-money option may go into the money). Time value cannot be negative, since an option-holder always has the choice of closing out an option position now and capturing the option's intrinsic value. The option's time value approaches zero as the expiration date approaches. An option that is deep in-the-money has high intrinsic value but little time value, while an option that is out-of-the-money has time value but no intrinsic value.

The theory of option pricing is based on the fact that an option is equivalent to a combination of other assets. To begin with, holding a call option is equivalent to holding a position in the underlying good or asset combined with a put option with the same strike price; this implies that one can deduce the price of a put option by knowing the price of a call option and the price of the underlying asset (for futures options, it is the price of the futures contract, not the good itself, that is relevant). Next, the possibility of carrying out riskless arbitrage between an option and the underlying asset--for instance, by buying a call option, immediately selling the underlying asset short, earning interest on the proceeds from the short sale and exercising the option at its expiration date--places bounds on options prices.

Furthermore, there is the concept of delta hedging: delta hedging uses the fact that the price of an option is related to the price of the underlying asset. Changes in the option's price will in general differ from changes in the price of the underlying good or asset, because the option is more highly levered. However, the behavior of an option price can be mimicked by holding a certain amount of the underlying asset financed by a certain amount of borrowing, provided that the changes in asset and option prices are small. This way of reproducing the behavior of the options price makes use of the relationship between a small change in the options price and the associated change in the price of the underlying asset, as given by the ratio "delta." The relationship between the option price and the price of the underlying asset is non-linear, so delta changes (at a rate gamma) with changes in the price of the underlying asset; as a result, the proportions of the underlying asset and borrowing would have to be adjusted continuously in order to mimic accurately the behavior of the option price. Because this continuously adjusting leveraged portfolio of the underlying asset mimics the behavior of a call option, it could be combined with writing a call option in order to construct a riskless arbitrage position, known as delta hedging (a form of delta hedging is actually used by issuers of over-the-counter options

in order to hedge their risks). Similarly, one could construct a riskless arbitrage position by buying a call option and taking a short position in the portfolio that reproduces the option's behavior. Tracing the way in which the proportions of different assets would have to be adjusted in order to maintain such a riskless arbitrage position is the basis of the modern theory of option pricing.

The foundation of the modern literature on options pricing is a paper by Fischer Black and Myron Scholes (1973): the Black-Scholes formula is a specific mathematical expression for the price of a European-style option. Underlying the Black-Scholes formula are the following assumptions: that frictions in markets for options, bonds and the underlying instrument are negligible, that there is a riskless interest rate that is constant over the life of the option, that a riskless arbitrage position between options and the underlying asset can be assembled (i.e., that there are no restrictions on short sales of options or the underlying instrument), that the underlying instrument bears no explicit return (such as interest or dividend payments) over the life of the option, that trading in markets for both options and underlying assets is continuous and that the price of the underlying instrument changes continuously at a random rate which is distributed log-normally with mean zero. Under these assumptions, the price of a European call option is given by

$$C = P\,N(X) - [e^{-rT}]S\,N(X - \sigma T^{-1/2})$$

where C is the price of the option, P the price of the underlying instrument, S the option's strike price, r the risk-free rate of interest, T the length of time until the option expires, σ the standard deviation of the price of the underlying instrument and N(X) the standard cumulative normal probability distribution; here, we define

$$X = \ln (P/S[e^{-rT}])/\sigma T^{1/2} + (1/2)\sigma T^{1/2}$$

Thus, the option's price is higher, the higher the price of the underlying instrument and the lower the option's strike price; this reflects the fact that the option only has intrinsic value to the extent that the price of the underlying instrument exceeds the strike price. It is higher the more distant is its expiration date; this corresponds to the idea that an option has time value. The standard deviation of the price of the underlying instrument is a measure of how variable or volatile is that instrument's price; a more volatile price, as reflected in a higher standard deviation, increases the value of the option. A longer time until expiration and a higher standard deviation of the instrument's price increase the option's price for essentially the same reason: either factor makes it more likely that the instrument's price will increase substantially over the life of the option. Either factor

also makes it more likely that the instrument's price will decrease substantially, but the option-holder's position is asymmetrical: his potential losses are limited to the amount of the option premium, while his potential gains are unlimited. Finally, a higher interest rate increases the price of an option: this is because, in order to duplicate an options position using the underlying instrument, one would have to borrow in order to finance a purchase of the underlying instrument (i.e., the option is more highly levered than is the underlying instrument); a higher interest rate makes it more expensive to duplicate an option in this way, and thus makes the option more expensive.

The Black-Scholes formula has opened up a large literature on option pricing, which extends the formula to more complicated situations and develops numerical methods of calculating the appropriate prices. Such methods are not only used to explain the existing structure of options prices; they are also often used by issuers of options as a guideline in deciding what price to quote, and by prospective purchasers of OTC options in order to determine whether a quoted price is fair.

An options premium must generally be paid "up front:" because it must be paid regardless of whether or not the option is exercised, this involves an immediate outlay. On the other hand, once the premium has been paid, there is no further commitment on the part of the purchaser: the risks incurred are limited to the amount of the options premiums. Examples of some recent options premiums are given in Table A11.

For example, in late May, the right to buy 112,000 lbs. of sugar at 9 cents per lb. in October cost 0.86 cents per lb., for a total premium of $963.20 per contract. The right to sell 125,000 West German marks at 0.61 cents per mark in July cost 1.76 cents per mark, for a total premium of $2,200 per contract. The right to buy a Eurodollar deposit in December at 93.00 (implying an interest rate of 7 percent) cost 0.04 points, implying a total premium of $400 per contract.

Table A11 illustrates some of the patterns already discussed: options that are further into the money have higher premiums (call premiums decrease down any given column, as the strike price increases; the reverse is true for put premiums). Options whose expiry date is more distant have higher premiums (both call or put premiums increase moving rightward along a row). Finally, note that some entries are blank: if an options exchange judges that there is insufficient interest in a particular combination of strike price and expiration date to ensure some degree of market liquidity, the exchange does not open trading in that particular contract.

The other element in the cost of using exchange-traded options is the commission that must be paid in buying or writing the option. (With OTC

Table A11. Some Examples of Futures Option Premiums

(Data for Wednesday May 25, 1988)

1. Sugar-World (CSCE)
(112,000 lbs; cents per lb.)

Strike Price	Calls			Puts		
	July	Oct.	Dec.	July	Oct.	Dec.
8.00	1.24	1.42	1.54	0.02	0.17	0.27
8.50	0.77	1.03	--	0.05	0.34	--
9.00	0.38	0.86	1.03	0.20	0.60	0.76
9.50	0.14	0.63	--	0.42	0.85	--
10.00	0.07	0.49	0.71	0.85	1.21	1.44
11.00	0.02	0.31	0.50	1.20	2.00	2.23

2. West German deutsche mark (IMM)
(125,000 marks; cents per mark)

Strike Price	Calls			Puts		
	June	July	Aug.	June	July	Aug.
57	1.73	--	--	0.01	0.05	--
58	0.77	1.48	--	0.04	0.15	0.31
59	0.11	0.75	0.96	0.38	0.41	0.62
60	0.01	0.29	0.52	1.28	0.95	1.18
61	--	0.11	0.25	2.27	1.76	--
62	--	0.04	0.13	3.27	--	--

3. Eurodollar (CME)
($1 million; pts. of 100 percent)

Strike Price	Calls			Puts		
	June	Sept.	Dec.	June	Sept.	Dec.
9175	0.58	0.32	0.31	0.004	0.27	0.59
9200	0.34	0.20	0.23	0.01	0.41	0.75
9225	0.13	0.12	0.16	0.05	0.57	0.92
9250	0.03	0.07	0.11	0.20	0.76	1.11
9275	0.01	0.04	0.07	0.43	0.98	1.31
9300	0.004	0.02	0.04	0.67	1.21	1.54

Source: The Wall Street Journal, Thursday May 26, 1988.

Notes: CSCE = Coffee, Sugar and Cocoa Exchange, New York; IMM = International Monetary Market, Chicago; and CME = Chicago Mercantile Exchange.

options, the transactions cost is incorporated into the premium quoted.) Commissions on futures options are typically of the same order of magnitude as those on the underlying futures contract.

Commodity Hedging: Examples

The following examples of commodity hedging are constructed using the prices prevailing on the Coffee, Sugar and Cocoa Exchange (CSCE) and the Chicago Board of Trade (CBT) on Wednesday, May 25, 1988.

Case 1: Commodity exports

Consider a sugar producer who plans to sell a shipment of 10,000 long tons (= 22,400,000 lb.) of sugar in October 1988. The price of raw sugar for delivery in a port in the country of origin has recently been $0.091 per pound. However, it is possible that the spot price in October will be either higher or lower. Consider the following alternative price outcomes and their implications for the producer's revenues:

Spot Price in Oct. 1988 ($/lb.)	Total Revenue (thousands)
0.06	$1,344
0.07	1,568
0.08	1,792
0.09	2,016
0.10	2,240
0.11	2,464
0.12	2,688

Clearly, a small difference in price can make a considerable difference to the producer's revenues, and therefore to his ability to meet other financial obligations. The risk associated with this price uncertainty is therefore of concern to the producer.

One way to hedge against the risk associated with fluctuations in sugar prices is to take a short position in the futures market. There is a futures contract for raw sugar, f.o.b. port of origin (Sugar No. 11; see Table A2) for the month of October. Each contract is for the delivery of 50 long tons (112,000 lbs.). The current October price is $0.0928 per lb.

The producer could sell 200 October Sugar No. 11 contracts short. This position can be reversed in October, by buying 200 October Sugar No. 11 contracts; by that time, the October futures price will have converged to equal the prevailing spot price. The producer's profits or losses will reflect any difference between the price at which the contracts were sold ($0.0928 per lb.) and the price at which they are bought again; for example, the profit or loss for various hypothetical alternative spot prices that may emerge are:

Spot Price in Oct. 1988 ($/lb.)	Revenue from Sale of Own Sugar (thousands)	Profit or Loss from Futures Position (thousands)	Net Revenue (thousands)
0.06	$1,344	+$734.72	$2,078.72
0.07	1,568	+ 510.72	2,078.72
0.08	1,792	+ 268.72	2,078.72
0.09	2,016	+ 62.72	2,078.72
0.10	2,240	- 161.28	2,078.72
0.11	2,464	- 385.28	2,078.72
0.12	2,688	- 609.28	2,078.72

This example illustrates an important aspect of hedging. Hedging by definition means taking on a risk that offsets an existing risk. Consider the third column of the table above: this column shows the profits and losses resulting from the futures-market position itself. This position entails the possibility of substantial profits or losses: taking this position in the absence of an existing risk would constitute speculation. However, as the fourth column shows, when this risky futures-market position is combined with the price risk initially faced by a sugar exporter, the two risks exactly offset each other, leaving the exporter with the certainty of earning net revenues of $2,078,720.

Clearly, the futures position has to be evaluated in the context of the producer's overall position, rather than in isolation: in particular, the wisdom of hedging is not contradicted by the fact that the hedge position may by itself turn out to be a losing one. As the example indicates, the producer would turn out, in hindsight, to have been better off unhedged if the spot price in October turns out to be above $0.0928; nevertheless, as the fourth column indicates, the hedge is perfectly successful, in that it eliminates all the price risk to which the producer is subject.

The fact that a riskless hedge can be constructed in this situation is a result of the assumption that the producer knows the quantity that he will be selling, that this quantity is an exact multiple of the contract size, and that the quality, location and delivery date of his product are the same as those specified in an existing futures contract. These assumptions imply that there is no basis risk, since in this case the basis converges to zero as the October delivery date approaches.

In order to take the futures-market position described, the producer would have to post initial margin. Initial margin on the Sugar No. 11 contract was recently $3,500 per contract, implying an initial outlay of $700,000 for 200 contracts. In addition, changes in the futures price result in the hedger's position being marked to market, requiring that he

post maintenance margin. The CSCE imposes a daily maximum of $0.005/lb. on price movements in the contract; if the price changed by its daily maximum amount, this would require the hedger to post an additional $112,000 in maintenance margin on a single day. The need to post margin thus impinges upon the hedger's cash flow; for some hedgers, these cash flow implications may be important in themselves, in addition to the gains and losses that have already been considered.

In order to complete a picture of the costs and benefits of hedging, the commissions paid to a broker to execute the contract should also be considered. Commissions are charged on a round-turn basis (i.e., a single commission to open and close a position), and are collected after the position is closed out. The CSCE does not fix commissions for its members, but allows them to be determined competitively; however, commissions have recently been in the neighborhood of $32 per round turn per contract. The total commission cost of the hedge described would thus be around $6,400.

Another question that should be asked is whether a hedging position such as the one described can be established without disrupting the market and moving the futures price against the hedger (i.e., down). The 200 contracts prescribed is less than the position limit of 4,000 contracts in any one month (or 6,000 in all months combined). Such a position is, however, large enough that it would have to be reported to the Commodity Futures Trading Commission (the CFTC Large Trader Reporting Level is 200 contracts or more if more than 100 contracts are acquired in a single week, this also has to be reported to the CFTC). From recent market data, it appears unlikely that 200 contracts would be enough to have an appreciable effect on market prices: this should be compared to a daily trading volume of 13,454 and an open interest of 147,449 contracts. The possibility of being constrained by position limits and/or of disrupting the market is of more serious concern for a producing country as a whole: for example, Brazil (the world's largest producer and third-largest exporter) would have had to sell about 50,000 Sugar No. 11 contracts in order to hedge its entire 1987-88 sugar exports.

An alternative method of hedging in the situation described in the example involves the use of futures options. The producer could buy put options on October Sugar No. 11 futures at a strike price of $0.09 for a premium of $0.006/lb.; buying puts on 200 contracts would entail a total premium outlay of $134,400. Alternatively, he could buy a put option that is further out-of-the-money, with a strike price of $0.08, for a premium of $0.0017; in this case, the premium outlay for 200 contracts would be $38,080. The following table characterizes the producer's revenues under alternative price scenarios:

Strike Price = $0.09

Spot Price in Oct. 1988 ($/lb.)	Revenues from Sugar Sale (thousands)	Profit or Loss from Options Position (thousands)	Net Revenue (thousands)
0.06	$1,344	+$537.6	$1,881.6
0.07	1,568	+ 313.6	1,881.6
0.08	1,792	+ 89.6	1,881.6
0.09	2,016	- 134.4	1,881.6
0.10	2,240	- 134.4	2,105.6
0.11	2,464	- 134.4	2,329.6
0.12	2,688	- 134.4	2,553.6

Strike Price = $0.08

Spot Price in Oct. 1988 ($/lb.)	Revenues from Sugar Sale (thousands)	Profit or Loss from Options Position (thousands)	Net Revenue (thousands)
0.06	$1,344	+$409.92	$1,753.92
0.07	1,568	+ 185.92	1,753.92
0.08	1,792	- 38.08	1,753.92
0.09	2,016	- 38.08	1,977.92
0.10	2,240	- 38.08	2,201.92
0.11	2,464	- 38.08	2,425.92
0.12	2,688	- 38.08	2,649.92

A number of things will be noticed in this example. One is that, when an exporter uses options to hedge against price uncertainty, not all of the uncertainty about his revenue is eliminated. If the market price turns out to be below the strike price of the put option, the producer can exercise the option, and thereby maintain his revenues at a minimum level. On the other hand, if the market price turns out to be above the strike price, the option expires worthless and the producer loses what he has paid in options premiums; however, in that eventuality he would still be able to take advantage of the higher prevailing price of sugar. Based on the data in these four tables, three comparisons can be made: (1) compared to going unprotected, the option involves sacrificing a limited amount of revenue in case the market price of sugar turns out to be high (above the strike price), in order to obtain the right to be compensated should the price of sugar turn out to be low (below the strike price); it is like buying insurance against unfavorable price movements at a fixed cost; (2) compared to hedging using futures, options involve sacrificing some revenue in case the market price of sugar turns out to be low (i.e., below the futures price), in order to preserve the right to profit in case the price turns out to be high: in effect, options allow

the hedger to preserve a partly open position, i.e., to speculate; and (3) buying an option with a lower strike price sets a lower floor to the hedger's revenues. If the price of sugar turns out to be low, this works to the hedger's disadvantage; if it turns out to be above the higher of the two strike prices under comparison ($0.09 in this example) the hedger benefits from the lower premium cost associated with a lower strike price, while either option would expire worthless.

Commissions on futures options are similar to commissions on the underlying futures contracts. Thus, the commission cost of the futures strategy described would be similar to that of the futures strategy (i.e., around $6,400). Options commissions must be paid when the option is purchased, in contrast to futures commissions which typically need only be paid when the position is closed out; thus the two strategies have *different implications for the hedger's cash flow*. The other cash-flow difference is that the options premium must be paid when the option is purchased, requiring an initial outlay of $134,400 in this example if the hedger buys the option with the higher strike price; this is in contrast to the initial margin outlay of $700,000 for the futures strategy. In addition, with the options strategy, once the premium and commissions have been paid, the hedger does not have any further obligation; with the futures strategy, the hedger may be required to post maintenance margin of up to $112,000 in a single day (if the price rises by its daily maximum amount of 1/2 cent per lb.).

In this example, the options strategy leaves the hedger with a greater degree of uncertainty about his revenues than does the futures strategy; he pays an option premium in order to obtain the right to profit from any favorable price movements.

Case 2: Timing of exposure

An important feature of the example presented so far is that the hedger expects to sell his output at a date for which a futures contract (or an options contract) exists. Such is not always the case, as futures contracts exist only for a limited number of delivery dates (for sugar, a maximum of six, but in practice recently, four per year) and do not extend very far into the future (for sugar, a maximum of eighteen months, but often in practice little more than a year). If a prospective hedger's existing exposure pertains to a date between the delivery dates of two existing contracts, he may wish to hedge by combining positions in both of these adjacent contract months. For example, if a producer plans to sell sugar in December, he can hedge by combining short positions in both October and March contracts. Such a strategy would eliminate much, but not all, of the price risk; the remaining risk is classified as basis risk.

A more complex problem arises if a prospective hedger's existing exposure is associated with a more distant date or dates. As an illustration, consider a producer planning to sell some sugar in November 1988, some in April 1989 and some in August 1989. There are two basic alternative methods of dealing with this situation: one, known as a strip hedge, would involve selling some of each of the contracts over the relevant period--that is, some of the October 1988 and the March, May, July, and October 1989. If such a strip hedge can be constructed, it can provide protection against much of the price risk. The main impediment to assembling a strip is that the market for the more distant contract months may be thin, or even nonexistent: for instance, in late May 1988, open interest in the July 1989 World Sugar contract was only 357 contracts and the October 1989 contract was not yet available.

An alternative to the strip hedge is the stack hedge. This involves taking a rather large position in a nearby contract month and then rolling over this position successively into later contract months. In the example mentioned in the previous paragraph, a producer planning in May 1988 to make a series of three sugar shipments in the following November, April, and August could begin by taking a large position in the October 1988 contract (which, with an open interest of 67,944 contracts in late May, is very liquid). In July, he could roll over four-fifths of this position into the March 1989 contract and keeping the remainder in the October contract, planning to settle in cash when October arrives. He could repeat this procedure in December, rolling over three-quarters of his March 1989 position into the May contract and keep the remainder for cash settlement in March. In February, two-thirds of the May position can similarly be rolled forward into July; in April, half of the resulting July position can be rolled forward to October (the rollover dates are chosen arbitrarily in this example, but would have to be chosen carefully in practice). The advantage of this strategy is that it provides a position that is rolled out evenly over a succession of contract months, without the need to deal at any time in the less-liquid distant months: in effect, the positions taken in the earlier months are being used as a hedge against movements in the futures price at which the later-month positions can subsequently be taken. The drawback of a stack hedge is that the hedger faces basis risk as his position is rolled over from one contract month to the next: the prices of the contracts bought and sold in each rollover may differ by an unpredictable amount. These rollovers also entail some additional transactions costs.

Both types of hedges therefore have advantages and disadvantages. In practice, stack and strip hedges should not be viewed as alternatives, but as elements that should be combined carefully as part of an overall strategy that effectively manages the hedger's risk at the minimum cost.

Case 3: Uncertain output

The hedger's problem can be explored further by considering the case of an exporter who is uncertain of the quantity that will be produced and exported. Output uncertainty is of obvious importance for many LDCs exporting agricultural commodities: given uncertainty about weather, pests, and other circumstances, it is difficult to predict in advance the quantity available for export.

As a simple modification of the example considered as Case 1, consider a sugar exporter who expects, on average, to sell 10,000 long tons of sugar in October, but is uncertain of whether actual output will be 8,000 or 12,000 long tons. The producer is concerned about his total revenue from the sugar sale, and thus is concerned with both price and quantity uncertainty. There is no organized market for hedging against variations in a particular producer's sugar output; however, the existence of quantity uncertainty affects the way in which the producer should deal with price uncertainty.

The following table shows how the producer's revenues depend on the price of the product when output turns out to be 8,000 or 12,000 long tons, respectively.

Spot Price in Oct. 1988 ($/lb.)	Sales Revenue when output=8,000 (thousands)	Sales Revenue when output=12,000 (thousands)
0.06	$1,075.2	$1,612.8
0.07	1,254.4	1,881.6
0.08	1,433.6	2,150.4
0.09	1,612.8	2,419.2
0.10	1,792.0	2,688.2
0.11	1,971.2	2,956.8
0.12	2,150.4	3,225.6

The producer can hedge by selling short in the futures market a quantity of the commodity equal to his expected output. If an output of 8,000 and an output of 12,000 long tons are considered equally probable, expected output is 10,000 tons. The producer can therefore sell short 200 October Sugar No. 11 contracts. The profits and losses associated with this futures position are the same as those given in Case 1 above, and are reproduced below for convenience. The net revenues associated with this hedged position are calculated, and depend on the level of output that materializes.

Spot Price in Oct. 1988 ($/lb.)	Profit from Futures Position (thousands)	Net Revenue if output=8,000 (thousands)	Net Revenue if output=12,000 (thousands)
0.06	+$734.72	$1,809.92	$2,347.52
0.07	+ 510.72	1,765.12	2,392.32
0.08	+ 268.72	1,702.32	2,419.12
0.09	+ 62.72	1,675.52	2,481.92
0.10	- 161.26	1,630.72	2,526.72
0.11	- 385.28	1,585.92	2,571.52
0.12	- 609.28	1,541.12	2,616.32

This example illustrates the difficulties associated with hedging against price movements when output is uncertain: it is not in general possible to eliminate all the risk associated with price fluctuations. If output turns out to be high, the hedge may be inadequate to offset the effects of price variability: this is shown by the fact that if output is 12,000 tons, the producer's net revenues still vary as the spot price varies. It is also possible that the futures-market position may turn out to be too large, as when output is low. In this case, the profits or losses from the hedge exceed the variations in revenue that they are intended to offset; this is reflected in the example, as when output turns out to be 8,000 tons the producer's net revenues actually vary inversely with the sugar price. As can be seen, there is a tradeoff between the concern that the hedge may turn out to be too large (if output is low) or too small (if output is high).

Under what circumstances is it appropriate to follow the hedging strategy of selling in the futures market a quantity equal to expected output? This strategy minimizes the variance of the producer's revenues under two conditions: one, if the prices and outputs that may emerge are distributed normally around their respective means (technically it is required that their joint third moments be zero) and two, if the covariance between price and output is zero. The second of these conditions is the more important for our purposes: it implies that high prices are as frequently associated with high outputs as with low outputs, and likewise for low prices. If the covariance between price and output were negative, low output would more frequently be associated with high prices and high output with low prices. This would be the case if there are important shocks, such as weather conditions affecting output in a number of producing areas, so that each producer's output is associated with variations in the world supply of the commodity which in turn affect world prices. In this case, the short position in the futures contract that is required to minimize the variance of the producer's net revenue is less than the average amount that he expects to sell (i.e., the hedge ratio is less than one). In the example, this is because in the negative-covariance case the outcomes with high prices and

low quantities--in which the producer turns out to be worse off in an already bad state--are relatively more likely to occur. Another way of looking at this is that, if the covariance between price and quantity is negative, price and quantity variations tend to have offsetting effects on the producer's revenues, thus lessening the need for additional hedging.

The other possibility is that there may be a positive covariance between price and quantity. In this case, high prices tend to be associated with high outputs and low prices with low outputs; for example, this would be the situation if there were important variations in demand that led both price and the quantity sold to vary together. If the covariance is positive, the producer who wishes to minimize the variance of his revenues should take a futures position that is greater than his expected output; this is because the producer is able to use a price hedge to protect, to some extent, against both price and quantity uncertainty. In this case, the optimal hedge ratio is greater than one.

Another strategy that may be superior when output is uncertain is one that combines futures with futures options. Consider the following hedge in the situation given in the example: the producer sells 8,000 tons of sugar (160 contracts) in the futures market, and buys put options on another 4,000 tons (80 contracts) at a strike price of $0.09 per lb. The following table shows the profits obtainable from this strategy, depending upon the spot price and the producer's output that materialize in October.

Spot Price in Oct. 1988 ($/lb.)	Profit from Futures (thousands)	Profit from Options (thousands)	Net Revenue (output=8,000) (thousands)	Net Revenue (output=12,000) (thousands)
0.06	+$587.78	+$215.04	$1,878.02	$2,415.62
0.07	+ 408.58	+ 125.44	1,788.42	2,415.62
0.08	+ 229.38	+ 38.84	1,698.82	2,415.62
0.09	+ 50.18	- 53.76	1,609.22	2,415.62
0.10	- 129.02	- 53.76	1,609.22	2,595.22
0.11	- 308.22	- 53.76	1,609.22	2,594.82
0.12	- 487.42	- 53.76	1,609.22	2,684.42

Clearly, this combination strategy is not capable of eliminating all the risk associated with both price and output fluctuations. What this strategy does do, however, is to provide some protection against the circumstances under which a pure futures hedge may turn out to be too large (if price is high and output low) or too small (low price and high output): as can be seen, the strategy puts a floor under the producer's revenues in each of these eventualities. If there is a negative covariance between variations in price and output, these are circumstances that are particularly likely to arise. The fact that this

strategy uses options only to hedge the portion of the output that is uncertain reduces the overall cost of the hedge.

However, it should be noted that the commission cost and the initial outlay on premiums and margin requirements are higher with this strategy than with the pure futures strategy. Since the hedger in this case is purchasing a total of 240 rather than 200 contracts, the commission cost is about 20 percent higher. This is also reflected in a larger initial outlay on premiums and margin.

As this example illustrates, hedging against commodity price uncertainty is a worthwhile objective, but some careful consideration is required in order to put it into practice. It is worth considering the covariances among different risks, as well as considering ways in which different hedging instruments can be combined. A hedging strategy must always be judged, not in isolation, but with reference to its implications for the hedger's overall exposure to risk.

Case 4: Commodity imports

Many developing countries are heavily dependent on imports of food and other commodities. Increases in the prices of imports can have significant adverse effects on debtor countries, as an increase in the import bill obviously reduces the country's ability to service debt.

Many of the developing countries' imports are manufactured goods, for which organized futures and options markets do not exist. In this case, hedging may still be possible, but it requires finding commodity contracts or other assets whose returns are correlated with the prices of the imported goods: this is known as cross-hedging.

Many developing countries are also major importers of some primary products. Developing countries are among the world's largest importers of wheat and corn, and also significant quantities of other food products. Many are also heavily dependent upon imports of petroleum and other products. Hedging against adverse movements in the prices of such commodities is possible within the existing set of markets.

As an example, consider a wheat importer who is planning to purchase 2 million bushels of wheat in December 1988. Although spot wheat prices in late May were around $3.40 per bushel, wide fluctuations in price are possible: the second column of the following table indicates the cost of the wheat purchase under several alternative scenarios.

The purchaser can hedge against the possibility that a high price of wheat will emerge by buying December wheat contracts in the futures market. Wheat futures are traded on a number of different markets,

including the Chicago Board of Trade (CBT), the Kansas City Board of Trade and the Minneapolis Grain Exchange; CBT prices are used in this example because this is the largest of the three markets. The December wheat price on the CBT recently closed at $3.62: the existence of a premium in the futures market reflects the cost of storing wheat between May and December. Each contract is for 5,000 bushels, so the importer would buy 400 contracts. The third column shows the profit or loss associated with this futures position in itself and the fourth shows the net revenue associated with this hedge.

Spot Price in Dec. 1988 ($/bu.)	Cost of Wheat Purchase (thousands)	Profit from Futures Position (thousands)	Net Expense (thousands)
2.50	$5,000	-$2,240	$7,240
2.75	5,500	- 1,740	7,240
3.00	6,000	- 1,240	7,240
3.25	6,500	- 740	7,240
3.50	7,000	- 240	7,240
3.75	7,500	+ 260	7,240
4.00	8,000	+ 760	7,240
4.25	8,500	+ 1,260	7,240
4.50	9,000	+ 1,760	7,240

Once again, it can be seen that hedging using futures can eliminate the risk associated with an increase in the price of wheat--while also, of course, eliminating the possibility of benefiting from being able to purchase wheat at an unexpectedly low price. This is seen by examining the importer's net expense, which is held at $7,240 regardless of the spot price of wheat that emerges.

Margin requirements for wheat futures were recently set at a minimum of $1,800 per contract; thus the total initial margin for this hedge would be $720,000. Maintenance margin is also set at a minimum of $1,800 per contract. At a commission rate of $30/round-turn, the commission cost of purchasing 400 contracts would be $12,000, and would have to be paid when the position is closed out.

An alternative hedging technique involves purchasing call options on 400 December wheat futures contracts. December futures call options at a strike price of $3.40 were recently trading at $0.33 per bushel. Thus the total cost of purchasing these call options would be $660,000. The effect of this options hedge on the net cost of the wheat imports is shown in the following table:

Spot Price in Dec. 1988 ($/bu.)	Cost of Wheat Purchase (thousands)	Profit from Options Position (thousands)	Net Expense (thousands)
$2.50	$5,000	- $660	$5,660
2.75	5,500	- 660	6,160
3.00	6,000	- 660	6,660
3.25	6,500	- 660	7,160
3.50	7,000	- 460	7,460
3.75	7,500	+ 40	7,460
4.00	8,000	+ 540	7,460
4.25	8,500	+1,040	7,460
4.50	9,000	+1,540	7,460

Thus, this hedge has the effect of putting a ceiling on the net expense of the wheat purchaser: the purchaser's maximum expense is $7,460,000. On the other hand, the purchaser can still take advantage of a fall in wheat prices. The net cost of the wheat purchased is lower if the spot price turns out to be below the option strike price of $3.40; the importer's cost of hedging is thus limited to the $660,000 that must be paid for the options premiums (as well as commissions of around $12,000).

Another factor that may be important for the wheat importer is basis risk. The wheat futures contract traded at the CBT is for delivery of any of a number of varieties of wheat typically grown in North America: No. 2 Soft Red, No. 2 Dark Hard Winter, No. 2 Hard Winter, No. 2 Yellow Hard Winter, No. 2 Dark Northern Spring, No. 1 Northern Spring, or No. 2 Heavy Northern Spring, with substitutions at differentials established by the Exchange. Delivery months are July, September, December, March, and May. Delivery must be made by delivering warehouse receipts issued against stock in warehouses approved by the Exchange in the Chicago Switching District or Toledo Ohio Switching District (with a discount of 2 cents per bushel applying to Toledo deliveries). An importer in a developing country may be concerned with the price of a different grade of wheat for delivery in a different month in a different location--for instance with the price of soft wheat for delivery in Bur Sa'id in January. The difference between the latter price and the price of the March CBT wheat futures contract in January is the relevant basis. The basis generally reflects the cost of storage (including the interest rate), the cost of transportation, the relative value that the market attaches to the different characteristics that are embodied in different grades or types of a commodity and the market's expectations about impending changes in supply and demand for the product. If the basis is just a constant price differential, it is not of great concern to the hedger; in that case, the importer can still eliminate all the risk using futures contracts. However, if there may be changes in the costs of transportation, storage, etc. that may lead to unpredictable change in the basis over time, there

is basis risk associated with hedging using organized futures and options markets. In this case, it is not possible to construct a perfect hedge. However, the hedger can still eliminate much of the risk associated with price fluctuations to the extent that the price of the hedging instrument is correlated with the spot price of concern to the hedger. In this case, the optimal hedge ratio depends on the regression coefficient of the relevant spot price on the futures price.

Another way in which importers and exporters can avoid basis risk is through the use of basis-priced contracts. For instance, an importer knowing that he will have to buy soft wheat in Bur Sa'id in January can make a contract in May to buy that wheat for 17 cents above the CBT March wheat price prevailing at that date in January. The exporter and importer are thus agreeing in advance to the basis, and are left bearing the risk of fluctuations in the CBT March wheat price. They can then make whatever arrangements they choose in order to hedge against movements in the CBT March Wheat price itself.

As will be clear from these examples, futures and options markets offer facilities that developing countries may use in order to protect themselves against commodity-price movements that may concern them either as importers or as exporters, as well as to protect against adverse interest- and exchange-rate movements. In practice, the use of these markets is not so straightforward as the simplest examples would suggest, but there are trading strategies that, when implemented properly, can deal with many of the complications. It is very important that staff be trained in the use of hedging techniques as well as in market conventions and procedures. When approached with due circumspection, these markets may be of significant use to debtor countries that wish to prevent their adjustment efforts from being disrupted by adverse price movements.

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