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Financial Derivatives I: A Bird's Eye View of the Products

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Abstract

Trading in derivatives has become an integral part of the global financial market. The average daily turnover in these markets is around USD 1,000 billion. The Indian financial market too is waking up to this new generation of financial instruments. It has already seen the introduction of *forward* and *swap* contracts in the market for foreign exchange, and the use of *options* bundled with long term bonds issued by financial institutions and corporate houses. However, derivatives trading, as an operational and intellectual exercise has not permeated beyond the select few, who are directly associated with these securities and contracts. Further, the Indian financial market is yet to see exotic financial instruments like *index and interest rate futures* and options on stocks which involve a clear understanding of the role played by the different types of derivatives, and ways in which they can be used. But the situation is likely to change if the committee formed by the Securities & Exchange Board of India (SEBI) under the chairmanship of L. C. Gupta recommends initiation of trading in such financial instruments. The limited purpose of this paper, therefore, is to provide a brief, yet clear, description of some of the derivatives that have become an integral part of major financial markets. The focus of the discussion will be the *nature* of these instruments, which has been highlighted through enumeration of some related strategies, and not the actual trading processes and regulations governing the same.

Introduction

Financial derivatives have tended to be in the media headlines, ever since the late 1980s. In the aftermath of the stockmarket crash in the USA on "Black Monday" of October 1987, many experts have opined that speculative trading precipitated the crash. Further that the vehicle for this speculation was the (then) exotic *stock index futures* contracts.[1] Several academics and experts jumped to the defence of this derivative product and verified, using empirical evidence, that there is no *prima facie* case indicting the product.[2] However, in the minds of people at large, an indelible image of derivative products had been etched: derivatives had in the public perception become synonymous with speculation and disaster.

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The events of the nineties did not help to improve the perception of derivatives even as the average daily turnover soared to USD 1 trillion. According to the Bank for International Settlements, at the end of March 1995, the global *notional amount* outstanding of just the over-the-counter

[1] Such stock index futures contracts with the Dow Jones index as the *underlying* has just come into existence. The index futures contracts blamed for the 1987 crash were based on the Standard and Poor's 500 index.

[2] F. R. Edwards and C. W. Ma, *Futures and Options*, McGraw Hill, 1992, p. 263-5.

(OTC) derivatives stood at USD 47.5 trillion, of which interest rate and foreign exchange instruments accounted for 61% and 37% respectively. During April 1995, the average daily turnover of these instruments stood at USD 880 billion. Notwithstanding the mind-boggling volume of daily turnover in derivatives markets, the public perception about these products continues to be negative.

Matters took a turn for the worse when little after the Kidders Peabody episode, the experience of Barings provided the media with umpteen headlines, and its previously little known "rogue" trader Nick Leeson acquired instant fame of the perverse kind. The "culprit" this time was derivatives in the form of stock index futures contracts, involving the Nikkei 225 index of Japan. No sooner did the curtain fall on the Barings saga, the world woke up to the scandal involving yet another rogue trader at Sumitomo Bank of Japan. The vehicle of disaster, people were amazed to discover, was the thus far deemed innocuous commodity futures contracts, specifically those involving trade in copper. The die was cast: derivatives were complicated instruments an understanding of which required the brains of a rocket scientist, and which charted a course full of disaster for investors and the institutions that represent them in the capital market.

. . . the use of derivative instruments in the debt and forex markets is on the rise. This increase is a consequence of the increased entry of corporate and other borrowers in the global market for funds

When viewed in the light of this perception, the reaction of Indian investors, interested intelligentsia and the media tend to merge into the global mosaic of opinions. As in the rest of the world, banks and corporate entities routinely enter into derivatives contracts with each other in the forward foreign exchange (forex) market, and long term bonds are routinely bundled with *call* and *put* options. Indeed, the use of derivative instruments in the debt and forex markets is on the rise. This increase is a consequence of the increased entry of corporate and other borrowers in the global market for funds, and of the intensification of competition among these borrowers in the domestic market. At the same time, however, claims abound that the Indian market is not yet ready for exotic financial instruments and that, therefore, it should continue with time tested systems such as *badla*.

What, however, are financial derivatives? Are they exotic and complicated things, which an average investor will be incapable of using gainfully? Are they merely vehicles of speculation, or can they be used to successfully hedge against price uncertainties in the money, capital and foreign exchange markets? Do derivatives come at a cost and, if so, how does one set about estimating this cost? How can an investor estimate the future price of an asset such that (s)he can use derivatives to hedge against adverse price movement? Does the introduction of derivatives make a market more volatile? How can derivatives trading be regulated? These are questions, which have haunted investors the world over. An understanding of the issues, however, has to be preceded by an understanding of the instruments themselves, and the way in which they are used by "the initiated few" around the world. This, indeed, is the limited mandate of this paper.

Derivatives Defined

What are derivatives? These are assets the payoff from which are contingent on the values of other *underlying* assets, i.e., the value of a derivative is *derived* from the value of the underlying *primitive* asset. The value of a primitive asset, on the other hand, depends on its own price level, and on payoffs, like dividends, that are associated with them. For example, the value of an equity share, a *primitive* asset, is the price of that instrument itself. But the value of an option on the same equity share is dependent on the latter's price, and is *derived* from it. The gains and losses from holding the equity share arise out of movements in its own price, while the gains and losses from the option depends on the movements in the price of the *underlying* equity share.

There are primarily three forms of financial derivatives: *options, forward contracts* and *swaps*. As we shall see later, swaps too can be viewed as a series of forward contracts. In essence, therefore, there are two main forms of derivatives: options and forward contracts. Both these forms of derivatives can be traded directly among players in the various markets, and they can also be traded in organised exchanges. The quasi-informal contracts among banks, financial institutions and corporate entities to buy/sell these derivative products constitute the so-called *over-the-counter* (OTC) market. The best known OTC market for financial derivatives is the forex forward market. The futures markets, on the other hand, exemplify the exchange-organised trading of derivatives. Futures contracts are standardised versions of forward contracts that offer greater liquidity and a lesser degree of flexibility as compared with forward contracts [see *Box 1*].

Scope of the Paper

In this paper, we shall focus on the nature and the pricing of forwards and futures contracts, options, as well as swap contracts. The forwards and futures markets are primarily the same in so far as foreign exchange trading is concerned. Hence, to an Indian investor, who associates such contracts by and large with the foreign exchange market, it would seem that there is little reason to discuss both. However, one has to take cognisance of the fact that there are other forms of futures contracts, involving interest rate and market indices, which do not have corresponding informal or forward markets. In view of this, therefore, futures contracts have to be separately brought into the ambit of discussion. Similarly, although swap contracts are, in principle, a series of forward contracts, they typically serve a purpose that is very different from that served by forward/futures contracts. Besides, while forward contracts are used mostly in the foreign exchange market, swap contracts are used frequently in both foreign exchange and debt markets. In the final analysis, all the different derivatives products — options, forwards and futures contracts, and swap contracts — serve purposes that might, on occasion, be somewhat overlapping, but which are largely unique. Each of them, therefore, merits a discussion in this paper.

There are primarily three forms of financial derivatives: *options, forward contracts* and *swaps*.

BOX 1: Forward and Futures contracts compared

	Forward	*Futures*
Size of contracts	Tailored to individual needs	Standardised
Delivery date	Tailored to individual needs.	Standardised
Contract prices	Established by the bank or broker via telephone contact with limited number of buyers and sellers	Determined by open auction among buyers and sellers on the exchange floor
Participants	Banks, brokers, multinational companies, commodity pools, and institutional funds	Banks, brokers and multinational companies, commodity pools, institutional funds and small traders
Commissions	Set by spread between dealer's buy and sell price	Published brokerage fee
Margins	None but compensating bank bank balances may be required	Margin deposit required
Clearing operation (financial integrity)	Handling contingent on individual banks and brokers. No separate clearing house.	Handling by the clearing house. Daily settlements by the market and variation margin requirements.
Marketplace	Worldwide via the telephone and computer networks	Central exchange floor with worldwide communications.
Accessibility	Limited to large customers	Open to anyone who needs hedge facilities or has risk capital with which to speculate
Regulation	Self-regulating	Self-regulating and regulated by the the Commodity Futures Trading Commission
Frequency of delivery	More than 90% settled by actual delivery	Actual delivery less than 1% of the volume
Price fluctuations	No daily limit	No daily limit

Source: F. R. Edwards and C. W. Ma, *Futures and Options*, McGraw Hill, 1992.

OTC Derivatives

As mentioned, derivatives are either transacted over the counter, or they are traded at exchanges. To recapitulate, "the main difference [between OTC and exchange based trading] is the formality of the structure."[3] While exchange based trading is strictly regulated, OTC contracts involve informal (yet binding) agreements between two parties.[4] The debt and foreign exchange markets provide the backdrop for much of the trading in OTC derivatives, and the two products that account for much of the trading in OTC derivatives are forward and swap contracts. The rationale for the dominance of OTC derivatives in these markets is easily understood. In both the debt and forex markets, traders and entrepreneurs face risks with respect to actual delivery of currency and interest payments which involve dates of maturity and amounts that are not standardised. For example, while each exchange based foreign exchange contract might involve USD 1 million, a trader might need forward cover for USD 1.4 million, thereby rendering the exchange-based product unsuitable for his/her requirement. Similarly, an exporter might have to make a import related payment on July 7 of a year, a date which does not correspond to the date of maturity of any foreign exchange futures contract. Hence these players are unable to use standardised exchange based trading as hedging tools, and thus enter into non-standard and quasi-informal agreements with market makers, by way of forwards and swap contracts.[5]

While exchange based trading is strictly regulated, OTC contracts involve informal (yet binding) agreements between two parties.

Forward Contracts

Each forward contract in the foreign exchange market typically involves a certain quantity of a currency, its delivery price in terms of some other currency, and a delivery date. For example, an Indian importer might want to lock in an INR-USD rate for a consignment it expects to import at the end of 6 months. If the value of the import is USD 1.6 million, and if the INR-USD exchange rate acceptable to the importer is INR 39 per USD, then (s)he would then enter the *long* side of a forward contract with a bank.

[3] M. Kohn, *Financial Institutions and Markets*, McGraw Hill, 1994, p. 456.

[4] In the context of financial futures, one of the parties is a bank while the other is either a trader or an investor. However, while financial futures per se were introduced in the seventies, OTC markets have existed for agricultural and non-agricultural commodities at least since the middle of the nineteenth century. In India itself, for example, traders offered relatively soft loans to farmers prior to the agricultural season, with an understanding that after the harvest the farmers would sell the produce to them at some pre-determined price. In effect, therefore, the traders and the farmers entered into commodity forward contracts with the former taking the *long* (or *buy*) position and the latter the *short* (or *sell*) position. It is evident that the rationale for the existence of such contracts is the need for risk-averse traders and investors to hedge against uncertainty in the future. This rationale, which is highlighted by the commodity forwards/futures market, also provides the backdrop for trade in financial forwards/futures contracts.

[5] A market is *made* when an intermediary is able to match a potential buyer, i.e., someone on the *long* side of a contract, with a potential seller, i.e., someone on the short side of the contract. Typically, when such a match cannot be found, the intermediating institution itself enters into contracts with those players who constitute the excess long or short positions. In other words, while there is a long position for every short position taken by *individual* players, and vice versa, an *intermediary* can have excess of long or short positions.

While Indian traders and investors are perhaps more familiar with forward contracts, derivatives transactions in the global foreign exchange market is dominated by *swap* contracts.

In other words, it would promise to buy USD 1.6 million from the bank after 6 months, at the aforementioned exchange rate. The long contract will protect the importer from any depreciation of the domestic currency beyond INR 39 per USD. Correspondingly, an exporter desiring to redeem his/her export earnings at some acceptable price will enter into the *short* side of a contract with the bank, thereby promising to sell USD (or some other currency) at some pre-determined price on the delivery date. The short contract will provide the exporter a cover against sudden appreciation of the domestic currency. Forward contracts comprise about 14% of all OTC foreign exchange contracts, and the average daily turnover of such contracts stood at USD 96 billion in April 1995.[6]

It is easy to see that forward transactions can take place because of the fact that banks are willing to accept the counterparty risks associated with their clients. A bank, which takes a short position is a vis-à-vis the importer and a long position vis-à-vis the exporter, tries to match its long positions with its short positions. Risk averse dealers match such contracts back-to-back such that they do not have a long (short) exposure that is not matched by the short (long) side of an agreement with some client. Usually, however, long and short exposures of banks do not cancel each other out, and the banks are left with net uncovered positions. The counterparty risk arising thereof is aggravated by the fact that forward contracts - unlike as in the case of futures contracts - are devoid of margin requirements and daily marking of the client-portfolios to the market. As a consequence, most banks in the USA for instance have been reported to enter into such contracts only with highly rated clients, thereby rationing most medium and small corporate and financial companies out of the OTC foreign exchange market.[7]

Swaps

While Indian traders and investors are perhaps more familiar with forward contracts, derivatives transactions in the global foreign exchange market is dominated by *swap* contracts.[8] Such contracts were introduced into the market for financial derivatives in 1981, by way of the first swap contract between International Business Machines (IBM) and the World Bank. Today, swap markets are dominated by interest rate and currency swaps. In the market for interest rate swaps, the two parties involved swap their interest rate obligations, and such swap contracts are usually negotiated when one investor has a fixed interest rate obligation while the other has a floating rate obligation. Currency swaps, on the other hand, are usually negotiated when two investors want to raise low-cost funds in two different currencies, where one of them has a price advantage with respect

[6] Bank for International Settlements, *Central Bank Survey of Foreign Exchange and Derivatives Market Activity 1995*, Basle, May 1996, p. 31.

[7] General Accounting Office, *Financial Derivatives: Actions Needed to Protect the Financial System*, Report no. GAO/GGD-94-133, 1994.

[8] According to the Bank for International Settlements, swap contracts comprised about 80% of the total turnover of foreign exchange contracts circa April 1995.

to loans denominated in one currency while the other has a similar advantage in respect of loans denominated in the other currency. In other words, the purpose of both interest rate and currency swaps is to minimise the project/trading costs of the players who negotiate the contract. The mechanics of these two forms of swap contracts have been further explained below.

Interest Rate Swap

How can an interest rate swap help attain the aforementioned goal? Let there be two firms A and B, where A is perceived to possess superior credit quality. In that case, A will be able to raise both long-term and short-term capital at smaller spreads over benchmark market rates such as the 30-year US T-bond yield and the London Inter-bank Offer Rate (LIBOR) respectively. Suppose that the spreads are 40 basis points (bps) and 20 bps respectively, when the values of the aforementioned yield and LIBOR are 7% and 5% respectively. Since B is a lower rated firm, it will have to pay higher spreads over these benchmarks. Suppose that B's spreads over the 30-year T-bond yield and LIBOR are 400 bps and 150 bps respectively. Hence, while B has to pay a higher premium than A for both long-term and short-term loans, its spread is lower for the latter than for the former. This is largely because long-term loans have a higher interest rate risk from the lenders' perspective than loans for a shorter term. Hence a borrower with a relatively poorer credit quality has to face a higher risk premium for long term, than for short-term loans. In other words, B has a comparative advantage in short-term loans than in long-term loans.[9] Stylised theories of trade suggest that correspondingly A must have a *comparative* advantage in long-term loans, and that A can B can mutually benefit from trade. The trade (or swap) can take place if A needs to raise short-term capital while B needs long-term financing for its project(s).

Subject to negotiations, firm A can raise long-term capital at 7.4% (say, for 20 years), and firm B can negotiate a renewable short-term loan at 150 bps over LIBOR. In other words, firm A raises funds involving a fixed interest rate, and firm B raises funds involving a floating interest rate. For the sake of simplicity, it can be assumed that the short and long-term term loans have the same principal amount (say, USD 10 million). A swap contract between firms A and B would then ensure that for the following 20 years B will pay A, a fixed rate of (say) 7.8%, and that for the same period of time firm A will pay B the spot value of the LIBOR. Firm A will then be known as the *floating rate payer* and firm B will be known as the *fixed rate payer*. The net interest rate obligation of firm A will then be (7.4 - 7.8 + LIBOR =) 40 bps lower than LIBOR, and the net interest obligation of firm

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[9] This becomes even more obvious when once takes cognisance of the fact that while the ratio of spreads for long term to short term loans is 4:2 for firm A, it is 4:1.5 for firm B. In other words, while firm B has to pay a higher absolute spread than firm A for both types of loans, it has to pay a relatively lower spread for short term loans. Hence, while firm B has an absolute disadvantage vis-à-vis firm A for both short term and long term loans, it has a comparative advantage for short-term loans.

B will then be (LIBOR + 1.5 + 7.8 - LIBOR =) 9.3%. Since, in the absence of the swap, the cost of capital would have been LIBOR plus 40 bps for firm A and 11% for firm B, both firms benefit from the swap contract. Indeed, even if an intermediary is required to make the market, and if the intermediary charges a spread of (say) 20 basis points from each of the two firms, the interest rate obligations of the firms will still be lower than their cost of capital outside the swap market.[10] However, it must be noted that in this transaction firm A is absorbing the credit risk of B.

Swap contracts allow firms to reduce their costs of funds. The rationale for this phenomenon lies in the fact that cost of borrowing significantly depends on the information regarding the borrowers that is available to the lenders

Currency Swap

The modalities of a currency swap are somewhat different but they too aim at reducing the cost of borrowing of the players who enter into such contracts. For example, a German firm operating in the US might need funds to expand its operations in the latter country. It can raise money at lower interest rates in Germany than in the US because it is better known in its own country. Presumably, therefore, the firm should raise money in Germany and move it to the US. The problem, however, lies in the fact, apart from the transaction costs, that the German firm will then become vulnerable to exchange rate fluctuations. The firm can, of course, hedge against such a risk with the use of forward contracts and/or currency options. Alternatively, it can enter into a currency swap agreement with a US firm, which requires DM for its operations in Germany. As with the German firm, the US firm too can raise cheaper money in the US than in Germany, but would then expose itself to transaction costs and exchange rate risks. A swap contract between these two firms can ensure that (i) the German firm will borrow in Germany for the US firm, and vice versa, and (ii) the American firm will be responsible for the interest payment and amortisation of the DM denominated loan of the German firm, and vice versa. In effect, the firms will thus be able to raise money at low interest rates for their overseas operations and, at the same time, avoid exchange rate risks altogether.

Economics of Cost Reduction

It is easy to see, from the above illustration, that swap contracts allow firms to reduce their costs of funds. The rationale for this phenomenon lies in the fact that cost of borrowing significantly depends on the information regarding the borrowers that is available to the lenders, and the amount of risk which the latter have to bear once credit is granted. This is obvious in the illustration involving the currency swap where each firm could borrow in a country where the lenders have more information about its respective creditworthiness. Let us, therefore, focus on the illustration

[10] In reality, intermediating international banks typically make the swap market against service charges. As in the forward market, the banks enter into separate swap contracts with fixed rate players and the floating rate players, and attempts to match each player with a player of the other type. However, *de facto* all intermediating banks have some open positions because it is virtually impossible to exactly match the exposures of the two types of players in the market. Hence, in the swap market too banks face significant counterparty risks.

involving the interest rate swap. Short-term loans are typically provided by financial institutions (FI),[11] while long-term funds are usually obtained by way of the markets for debt securities. Financial institutions have an informational asymmetry vis-à-vis the borrowers and this gives rise to risk of default, or *credit risk*. If, at the same time, these lenders have to offer credit at fixed interest rates, then they also face *interest rate risk* given that there might be a mismatch between their fixed lending rates and the variable interest rates on their liabilities. Firm B, on the other hand, faces the problem that its low perceived creditworthiness forces it to pay a very high premium in the market for debt securities. The swap enables firm B to do two things. First it is enabled to borrow at a smaller spread from banks, which do not have to bear the interest rate risk, since they lend at LIBOR-plus basis. Second it uses firm A's perceived credit quality to borrow long-term at a rate that lower than the likely coupon on its own bonds. The implicit underwriting of firm B's *de facto* debt in the long-term market relieves the lenders in this market from credit risk, and they are better able to handle the interest rate risk because purchasers of bonds usually have long-term fixed rate liabilities that match their long-term fixed rate assets. In other words, the two firms are able to effectively borrow at lower rates with a swap than otherwise because the associated risks of the lenders are reduced both in the short and long-term debt markets.

Pricing of Swaps

In reality, interest rates and exchange rates that are determined for swap contracts are the fruits of negotiations between players and market makers (i.e., banks). Hence actual prices are essentially determined by the bargaining powers of the former vis-à-vis the latter, and the nature of their relationship. It would hardly be surprising, for example, if State Bank of India (SBI) offers a better swap rate to Indian Oil Corporation (IOC) than to a smaller player in the foreign exchange market. What, however, would form the benchmark for the determination of such a price? The answer is that, arbitrage is not possible in a competitive environment. If a player can enter into both forward and swap contracts with a bank to cover its exposure in a market, then its costs of using the alternative hedging tools ought to be the same.

It is evident from the above illustrations that a swap contract can be replicated with a number of forward/futures contracts. For example, the German and the US firms which entered into a currency swap contract essentially agreed to deliver a predetermined amount of USD and DM respectively at the end of each year, for a certain number of years. In other words, these firms have taken a series of short positions in the currency forwards/futures market for the given number of years. This equivalence of forwards/futures and swap contracts plays a key role in the determination of the benchmark price of swap contracts.

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[11] The term financial institution is used in this paper to include commercial banks, development financial institutions and large financial service companies.

How can this benchmark price be determined? As mentioned above, this price is determined by the equalisation (through a competitive and efficient market) of the costs of entering into forward and swap contracts. Suppose there are two alternative ways in which an investor can hedge his/her foreign currency exposure for a two year period: (i) (s)he can enter into two forward contracts involving a commitment to receive/deliver USD C_1 at the end of the first year and USD C_2 at the end of the second year, or (ii) (s)he can enter into a swap contract which involves a commitment to receive/deliver some fixed amount, namely, USD C*, at the end of each of the two years. If the markets are efficient, arbitrage opportunities should not persist and hence the costs associated with the two strategies should be equal. In other words, the discounted value of the cost of the forward contracts should equal the discounted value of the cost of the swap contracts. Given the magnitude of C_1 and C_2, and the appropriate discount rate, therefore, the benchmark price of the swap contract (C*) can be determined. If the appropriate discount rate is given by r, then the following condition should be satisfied in an efficient market:

$$\{C_1/(1 + r)\} + \{C_2/(1 + r)^2\} = \{C^*/(1 + r)\} + \{C^*/(1 + r)^2\}$$

The "fair" price of the swap contract (C*) can, therefore, be determined, given the values of r, C_1 and C_2.

While OTC derivatives continue to dominate the foreign exchange and debt markets, the futures market for financial derivatives has seen a sharp increase in its turnover over the past decade.

Futures

While OTC derivatives continue to dominate the foreign exchange and debt markets, the futures market for financial derivatives has seen a sharp increase in its turnover over the past decade. The reason for the emergence of this exchange-based market is twofold. First, the nature of the OTC market is such that the intermediating bank is exposed to large counterparty risks. Hence, most such banks restrict their OTC clientele to other established banks and highly rated corporate firms. In other words, medium and small players are effectively rationed out of the OTC market. Second, since OTC contracts are agreements between the players and the market makers, and because the contracts are tailored to suit the specific needs of the former, such contracts are *de facto* non-negotiable. As a consequence, OTC contracts are highly illiquid. Hence, the need for the existence of a liquid market for forward contracts, which could cater to a larger number of players, led to the emergence of futures markets.

Although forwards and futures markets, in principle, serve the same purpose, i.e., minimisation or elimination of future uncertainties, they significantly differ with respect to the risk-taking behaviour of the participants. The forwards market is typically used by traders and investors who want to hedge against their future risks, and this market is marked by actual delivery of the underlying asset in most cases. The standardisation of contracts and the consequent liquidity of the futures market, on the other hand, make such a market better suited for speculative activities. A player can, for example, bet on the appreciation of a currency and enter into the short side of a contract, and then quickly close his/her position by entering the long side of a similar contract if (s)he revises his/her expectations. As such, the essential difference between hedgers and speculators can perhaps be summarised thus: Hedgers try to minimise their exposures to price fluctuations by locking into future prices, as is largely the case of the forwards market, while speculators attempt to benefit from the price movements *per se*, by anticipating future movements and thereby taking short or long positions which, they feel, will be translated into significant profit.[12]

The significant presence of speculative activities in financial futures markets is often used as a rationale for discouraging introduction of these products. A detailed analysis of the pros and cons of speculation lies outside the scope of this paper and, at this point, it suffices to say that speculation is *required* for the existence of the futures market. By definition, futures trading involves purchase or sale of commodities or other assets in the future, and all transactions in the future are uncertain. If, therefore, all the participants in a futures market are hedgers, i.e., risk averse, then each one of them would ask for a suitable compensation, i.e., risk premium, in order to assume any risk that is associated with the purchase of a futures contract written by one of the other participants. As a direct consequence of such behaviour, the transaction costs in futures markets would be prohibitively high, and in some cases it would not be possible to make the market. For example, a producer-importer, who takes production related risks but is averse to risks associated with exchange rate fluctuations, is able to lock in a future INR-USD rate for an acceptable premium only because some other investor, who wants to earn a profit by way of exchange rate fluctuations, bears the exchange rate risk which the producer-importer wants to be rid off.

The significant presence of speculative activities in financial futures markets is often used as a rationale for discouraging introduction of these products.

How exactly does futures trading work? Abstracting from the protocols governing the trades, the buyers take *long* positions on contracts with the clearinghouse, and correspondingly the sellers take *short* positions with the house. In other words, on the delivery date, a seller is not responsible for direct delivery to a buyer, and the buyer is not responsible for directly taking delivery from a seller. Both the buyer and the seller are respectively responsible for taking delivery from and making delivery to the clearinghouse. As a consequence, the risk of default is completely eliminated for the buyers and the sellers. The risk of default, as well as the price risk arising from mismatch of price quotes between long and short contracts, is

[12] Initially, it was felt that futures markets merely offered a convenient way to hedge against risks that could potentially arise in the future, and that futures trading was a risk-sharing mechanism which enabled such hedging. Later, however, economists came around to the view that speculation was of significant importance, and that, in fact, players in the futures markets were often both hedgers and speculators. A firm, for example, might hedge against its foreign exchange exposure with respect to its imports, and might simultaneously speculate in the forwards/futures market using the foreign exchange earnings from its exports. For a fuller discussion on hedging and speculation, see B. S. Yamey, "The economics of futures trading: Some notes and queries," in M. E. Streit (ed.) *Futures Markets: Modelling, Managing and Monitoring Futures Trading*, Basil Blackwell, 1983.

borne by the clearinghouse, or the middleman in the case of forward trading.[13] In sharp contrast, in an options market issuers of securities and investors directly interact with each other, and hence the risk of default is borne by the owner of an option.

Three types of futures contracts dominate trading in exchanges across the world — those involving stock market indices, interest rates, and exchange rates. Of these, the latter two account for over 90% of trade in futures contracts. However, in the media, stock index futures tend to attract far greater attention. Stock index futures are likely to be introduced in India, with the NSE-50 of the National Stock Exchange as the underlying index.

Foreign currency forwards contracts were developed as a response to the collapse of the Bretton Woods system of fixed/pegged exchange rates and the consequent evolution of floating exchange rate regimes.

Foreign Currency Futures

Foreign currency forwards contracts were developed as a response to the collapse of the Bretton Woods system of fixed/pegged exchange rates and the consequent evolution of floating exchange rate regimes. The increased volume of international trade and global capital flows since then, has increased manifold the exposure of traders to exchange rate risks and, as a consequence, currency futures contracts have emerged as a key component of the market for financial futures, the *notional amount* associated with it being second to only that of financial futures.[14] Apart from the US dollar (USD), the most frequently traded contracts involve the British pound (UKP), the Canadian dollar (CD), the Deutschemark (DM), the French franc (FF), the Japanese yen (JPY), the Swiss franc (CHF) and the Australian dollar (AD).

Since India has growing forwards market in foreign currencies, and given that forwards and futures contracts differ only to the extent that the latter are standardised while the former are tailored to individual needs, a detailed description of the implicit hedging strategies is perhaps unnecessary. Further, the OTC/forwards market in foreign exchange has already been discussed in the previous section. However, as with other futures

[13] Middlemen in the forwards and futures markets deal with the aforementioned risk in different ways. Middlemen in the forward market maintain a bid-ask spread, i.e., a difference between the buying and selling prices of the commodity or asset that is being traded, and this spread serves as a compensation for the risk that they take. Further, these middlemen often deal with only large traders who have compensating bank balances, thus reducing the risk of their portfolio. Futures clearinghouses, on the other hand, mark assets to the market daily and require traders to maintain minimum margins with the house. The margin is debited or credited daily, depending on whether the investor loses or gains at the end of the day's trading, and margin calls are made if the margin requirement is not met after the portfolios have been marked to the market.

[14] In the market for currency futures (and swaps), actual delivery of the underlying asset is rare. Each such contract usually involves a notional amount (say, USD 1 million) and, abstracting from the practice of marking to market all contracts on a daily basis, "delivery" typically involves a transaction of the profit between a long and a short trader. If, for example, a futures contract with a notional amount of USD 1 million involves a price of USD 1 = INR 39, and the spot price on the delivery date is USD 1 = INR 39.50, then the long position gains INR 500,000 and, correspondingly, the short position loses INR 500,000. The "delivery," in such an event, would involve a transaction of INR 500,000 between the long and the short traders, as opposed to an actual delivery of USD 1 million.

contracts, pricing plays an important role in the market for currency futures, and hence the mechanism for the determination of a benchmark price for these futures should be brought into focus. Once again, the underlying logic of the pricing process is that if markets are efficient, which includes unrestricted capital flows across international borders, then the futures prices should disallow the existence of arbitrage opportunities. Specifically, pricing in currency forward/futures markets is based on the logic of *covered interest parity condition*. This condition stipulates that the forward premium for a currency is equal to the differential between the interest rate in that country and the interest rate in the country with respect to whose currency the exchange rate is defined [see *Boxes 2 & 3*].[15]

While all futures contracts denominated in all currencies can be used to hedge foreign currency exposures and exploit arbitrage opportunities, however rare, USD denominated contracts play a crucial role in the market that cannot always be replicated by futures contracts involving other currencies for purposes of settlement. This is a consequence of the fact that USD is an internationally accepted currency, and hence it is usually possible to find USD denominated futures contracts for any two currencies (say, CHF and INR), even if futures contracts permitting locking in of an exchange rate between these (non-USD) currencies are not traded. In such an event, the two USD linked futures (i.e., USD-CHF and USD-INR) contracts can be used to create synthetic positions, which can help develop a cross-hedge between the two other currencies. For example, suppose that an Indian importer proposes to take delivery of equipment from a Swiss manufacturer in the future, and that (s)he is apprehensive about a possible appreciation of the CHF vis-à-vis the INR. As such, (s)he would prefer to lock in a INR-CHF exchange rate by buying CHF into the future, i.e., (s)he will go long on a INR denominated CHF futures contract. However, suppose that futures contracts involving the INR-CHF exchange rate are not traded. The importer can then go long on the USD denominated CHF contracts and lock in an USD-CHF rate. But (s)he will now have to purchase the USD required to meet his/her future CHF obligations, and hence (s)he would go long on an INR denominated USD futures contract to lock in a INR-USD rate. In the final analysis, the CHF exposure of the importer remains hedged.

Specifically, pricing in currency forward/ futures markets is based on the logic of *covered interest parity condition.*

Interest Rate Futures

Integration of financial markets around the world and increasingly fewer restrictions on capital movements, together with deregulation of

[15] Deviations from the covered interest parity condition can arise as a consequence of transactions costs, costs of gathering and processing information, government intervention and regulation, financial constraints and capital market imperfections, and non-comparability of assets. Empirical evidence from Britain, for example, suggests that the deviation from the parity condition decreased from over 4% in the pre-liberalisation era to less than 1% in the post-liberalisation era. In other words, once restrictions on capital flows are removed, the parity condition will (more or less) be satisfied.

BOX 2: Determination of exchange rate futures prices

Let the interest rate in the domestic economy (D) be lower than that in the foreign country (FC). Then a domestic investor will convert the domestic currency into foreign currency in the spot market, invest it in the foreign country, and upon receipt of interest reconvert the funds (i.e., principal plus interest) into the domestic currency into the future. Suppose that the annual interest rates in the domestic and foreign economies are r^D and r^{FC} respectively. If, therefore, the amount of funds available to an investor is Q_t^D, and if the exchange rate (i.e., units of domestic currency per unit of the foreign currency) is E_t, then he will convert Q_t^D into Q_t^{FC} amount of foreign currency such that

$$Q_t^{FC} = Q_t^D / E_t$$

If now, this amount is invested offshore at the foreign rate of interest, then the total payoff at the end of the year, i.e., principal plus interest payment, will be

$$Q_t^{FC} (1 + r^{FC})$$

Hence, when the investor reconverts the payoff into his domestic currency after one year, at the (future) exchange rate given by F_T, the total payoff in terms of the domestic currency will be

$$\begin{aligned} Q_T^D &= Q_t^{FC} (1 + r^{FC}) F_T \\ &= Q_t^D (1 + r^{FC}) F_T / E_t \end{aligned}$$

and the (gross) rate of returns on the investment will be

$$Q_T^D / Q_t^D = (1 + r^{FC}) F_T / E_t$$

If the principal were invested in the domestic economy, the (gross) rate of return would have been $(1 + r^D)$, and in the presence of an efficient market the rates of return should have been equal, given the implicit assumption of zero cost of transfer of funds and zero brokerage fees. Hence,

$$(1 + r^{FC}) F_T / E_t = (1 + r^D)$$

such that

$$F_T = E_t (1 + r^D) / (1 + r^{FC})$$

This is the so-called *interest rate parity theory*, which helps establish a relationship between the spot exchange rate and the forward/futures rate. In general, if the delivery date of the exchange rate futures is t periods into the future, the relationship is given by

$$F_T = E_t [(1 + r^D) / (1 + r^{FC})]^t$$

Source: F. R. Edwards and C. W. Ma, *Futures and Options*, McGraw Hill, 1992.
Z. Bodie, E. Kane and A. Marcus, *Investments*, Irwin, 1993.

BOX 3: Covered Interest Parity and Deviations

Let us suppose that an Indian investor has two alternatives: (s)he can invest in Indian securities which pay i percent interest per annum, or (s)he can invest in US securities which pay r percent interest per annum. Suppose that the prevailing exchange rate is INR e per USD. If the investor invests the money in Indian securities, his/her returns will be $(1 + i)$. Alternatively, (s)he can purchase USD $(1/e)$ with the Indian currency, and thereby get a return of $(1/e)(1 + r)$ at the end of the year. However, since the investor would finally like to realise his/her returns in rupees, (s)he will have to sell USD in the forward market to convert his returns in the United States into the local currency (i.e., INR). If the one year forward rate is INR F per USD, then the returns to the investor from his/her investments in the US will be $(F/e)(1 + r)$.

In other words, if the investor invests in India, his/her returns are determined solely by the domestic interest rate. On the other hand, if (s)he invests abroad, then his/her returns will be determined by the foreign interest rate, *as well as by the appreciation/depreciation of the domestic currency vis-à-vis the foreign currency*. The investor will compare the values of $(F/e)(1 + r)$ with $(1 + i)$ and decide whether to invest in India or the US. (S)he will invest in India if the value of the *covered interest differential*

$$(F/e)(1 + r) - (1 + i)$$

is negative, and vice versa. If capital markets are well functioning, however, arbitrage will ensure that any difference between the rates of return disappear such that, eventually, the covered interest differential equals zero. Hence, in equilibrium,

$$(F/e)(1 + r) - (1 + I) = 0$$

which, after algebraic simplification, yields

$$(F - e)/e = i - r$$

or the *covered interest parity condition*.

The condition implies that if, in equilibrium, the forward premia for the USD is x% (vis-à-vis the rupee) then the interest rate differential between India and the US should also be x%. In other words, any gain made from the investment in US securities by way of the depreciation of the rupee should equal the gains made from investment in India by way of the higher domestic interest rate. Otherwise, there will exist arbitrage opportunities that can be exploited by the investors. If the rate of depreciation of the rupee is 7%, for example, and the Indian interest rate is 5% higher than the US interest rate, it would be more profitable for an investor to invest in the US than in India, and then bring the returns back to India.

. . . continued on following page

As such, the covered interest parity condition is rarely satisfied, if at all. Deviations from it may arise as a consequence of the existence of transactions costs, costs of gathering information, government restrictions that prevent free flow of capital across borders, and the fact that the differences in the risks associated with the different countries distort perceptions about the acceptable levels of interest rates. More importantly, however, even if the interest rates for comparable assets in two countries can be locked in with certainty, there is no guarantee that the difference between these rates will equal the forward premia which reflect the expected rate of depreciation of the domestic currency. For example, abstracting from costs and risk differentials, let us suppose that the coupon rates on 1-year treasury bills in India and the US are 8.5% and 5.5% respectively. Given the covered interest parity condition, this would imply a forward premia of (8.5 – 5.5 =) 3%. However, in reality, the expectations about the future rate of depreciation of a currency depends on a number of factors other than capital flows, and hence the 1-year forward premia could easily be (say) 2% or 4%. Currently (Dec 1997) the annualised premia for six month forward contracts are in the region of 8%. At the end of the day, therefore, the market data can at best approach the covered interest parity condition, without actually satisfying the condition fully.

. . . capital flows to these countries are likely to be much more sensitive to *perceptions* of country-risk of the investors than on the so-called *fundamentals*.

interest rates in a large number of countries, have increased the volatility of interest rates across the globe. The resultant interest rate risk is particularly high in developing countries which can see sudden inflow and outflow of capital, given that short (and perhaps even medium) run capital flows to these countries are likely to be much more sensitive to *perceptions* of country-risk of the investors than on the so-called *fundamentals*. Further, even if the extent of fluctuations in the domestic interest rate is not high, an investor or financial institution in a developing country which has a large interest rate exposure can potentially suffer significant losses that in turn, may lead to panics, increased fragility of the financial system, and structural problems.[16] The problem has been exacerbated by the manifold increase in the number of institutional investors like pension and provident funds, that have fixed-income obligations. Hence, there has been an increase in the need for products, which can be used to hedge against sudden movements in interest rates, thereby providing a strong justification for the use of interest rate futures.

How can interest rate futures be used to hedge against interest rate fluctuations? Suppose that a financial institution issues bonds valued at INR

[16] Interest rate risk is much more than a theoretical abstraction. The Industrial Credit and Investment Corporation of India (ICICI) floated long term bonds earlier this year, with coupon rates of 16.5%. Soon after the bonds hit the market, the Reserve Bank of India lowered the bank rate by 1 percentage point, thereby pushing down the market interest rate by 75-100 basis points. While ICICI minimised its loss by not using its greenshoe option, in the absence of suitable hedging instruments, it could not avoid loss on account of the higher coupon rates on its bonds.

1 billion with a coupon rate of 12%. Assume that the bond has been finely priced with just the "right" spread over the yield of the risk-free government bond.[17] If, now, the central bank raises the bank rate by 1 percentage point just prior to the bond issue, resulting in an overall increase in the market rates of interest, then the coupon rate offered by the FI might no longer be attractive, and hence the FI might be forced to offer a higher rate (say, 13%) for the bonds, the alternative being a postponement of the bond issue. The increase in the FI's burden of annual interest payment will, in such an event, be INR 10 million (i.e., 1% of INR 1 billion). Suppose that interest rate futures contracts involving 364-day T-bills were available as a hedging instrument, the par value of each T-bill being INR 100. Further assume that the spot price of each T-bill falls from INR 95 to INR 94 following the rise in the interest rate.[18] If, therefore, each T-bills futures contract called for delivery of INR 1 million par value of T-bills (i.e., 10,000 T-bills) on the delivery date, and if the FI had shorted T-bill futures contracts, then its profit per contract would have been (1 x 10,000 =) INR 10,000.[19] In other words, the FI could have perfectly hedged its interest rate exposure by shorting (10 million /10,000 =) 1,000 T-bills futures contracts.

As highlighted in the above example, interest rate futures contracts are written on fixed income securities like government and corporate bonds. Since the market for government debt securities is usually much more liquid than markets for corporate debt instruments, futures contracts involving the former dominate the interest rate futures market. In the United States, for example, interest rate futures contracts use T-bills, T-notes, T-bonds and municipal bonds as the key underlying securities for interest rate futures. The other frequently used interest rate futures contracts are those involving Eurodollar deposits and Eurodollar certificates of deposit. The perceived higher safety of contracts involving US government securities is reflected by the *Ted* spread, i.e., the spread between the price of 3-month US T-bill contracts and that of 3-month Eurodollar time deposit futures contract. The price of Eurodollar futures always exceeds the price of US T-bill futures, indicating higher perceived risk associated with the former, and the spread has historically varied between 65 bps and 200 bps. The prices of these futures contracts are determined under the assumption of efficient markets,

. . . interest rate futures contracts are written on fixed income securities like government and corporate bonds.

[17] In financial models, such "fair" pricing is estimated by taking into account the relative riskiness of the asset vis-à-vis risk free assets like government securities. The paradigm which facilitates the estimation of the (risk adjusted) fair price is the capital asset pricing model.

[18] It is being assumed that a T-bill is a zero coupon bond and is sold in both primary and secondary markets at market-determined discount rates. Hence, any increase in the market rate of interest would increase the discount rate on T-bills, thereby reducing the price at which they are sold in the spot market.

[19] Note that "shorting" implies that the FI would have "borrowed" 10,000 T-bills (per futures contract) from some other investor and sold them at the prevailing spot price, with a binding agreement to replace the same number of T-bills in the "lender's" portfolio within a certain number of days. Hence, if the price of T-bills fell after the FI had "sold" the bills, then the replacement cost of the T-bills would have been lower, thereby generating profits for the FI.

which do not permit arbitrage [see *Box 4*].[20] It has been observed that, in general, the differences between theoretical and actual futures prices are not significant. As in the case of options and index futures, any mismatch between these prices can be exploited by an investor to reap arbitrage profits.

Stock Index Futures

Stock index futures have gained worldwide popularity, since their introduction by the Kansas City Board of Trade in 1982.[21] What purpose do stock index futures serve? In principle, if a secondary market for equities is efficient then it will incorporate all available information into the price quotes quickly such that all share prices will reflect the information at all times. In other words, future stock prices can be predicted only if future information can be predicted. However, since precise prediction of future information cannot be predicted given the current set of information, by the same token future prices in the equity market cannot be accurately predicted on the basis of the data on past prices. The implication of this *efficient market hypothesis* is that, in the long run, it will be virtually impossible to *systematically* beat the market, i.e., generate higher returns than dictated by overall market sentiments.[22]^ Hence, the best strategy for risk averse institutional investors like pension funds, who usually enter the market for the long run, is to effect passive portfolio management.

. . . such an institutional investor can diversify its portfolio to the extent that it reflects the structure of the market, and then passively accept the market trends. . .

In other words, such an institutional investor can diversify its portfolio to the extent that it reflects the structure of the market, and then passively accept the market trends, deciding merely how much of its funds to put into the equity portfolio (as opposed to bonds and treasury bills). However, the composition of the market changes frequently, in terms of the proportion of market capitalisation accounted for by individual companies, and hence the investor's equity portfolio has to be readjusted often to take into account these changes. The obvious problem with passive portfolio management, therefore, is that an investor has to buy and sell equity very often, to keep his/her portfolio aligned with the broader (equity) market structure. But, since buying and selling shares involve brokerage fees, the

[20] *Box 4* illustrates the pricing of short-term interest rate futures contracts involving T-bills. The principle involving the pricing of long-term interest rate futures contracts is the same. However, estimation of prices of long-term bonds involves *duration* and/or *regression* analyses that lie outside the scope of this paper. Hence, an illustration of the pricing of long-term interest rate futures has not been presented herein.

[21] Some of the major stock indexes which underlie stock index futures contracts world-wide are Standard and Poor's (S&P) 500, (S&P) 400, (S&P) 100, Value Line and New York Stock Exchange (NYSE) Composite of the United States, FTSE 100 of the United Kingdom, Hang Seng of Hong Kong, Nikkei 225 of Japan, and CAC 40 of France.

[22] Note that this does not preclude the fact that an investor can "beat" the market in the short run. The efficient market hypothesis simply claims that, under the assumption that information is disseminated quickly and efficiently through prices and otherwise, an investor cannot beat the market consistently unless (s)he is in possession of information which others do not possess. In the information age, sans insider trading and similar activities, and under the reasonable assumption that the cognitive powers of investors cannot differ significantly in the long run, it would be extremely difficult to explain the phenomenon of an investor repeatedly beating the market over an extended period of time.

BOX 4: Determination of interest rate futures prices

Suppose that an investor has to ensure a cash flow of INR 100 after 168 days. (S)he has two choices: (s)he can either purchase a T-bill with a par value of INR 100 that will mature after 168 days, or she can take long position on a T-bill futures contract which assures delivery of the T-bill after 40 days. Given the opportunity cost of funds, the latter option saves the investor the cost of carrying the T-bill for the first 40 days.

If the discount yield for the T-bill is 8%, the discount on the T-bill in the spot market will be

= *spot price* x *annualised discount yield* x *fraction of the year left till maturity*
= 100 x 0.08 x (168/360)
= 3.73

and hence its spot price will be (100 - 3.73 =) INR 96.27.

Let the money market interest rate for 40 days, an indicator of the opportunity cost of funds, be 9%. The cost of carrying the T-bill should equal the opportunity cost of the funds tied up in it and, hence, the cost of carrying the T-bill is given by

= *spot price* x *annualised money market rate* x *fraction of the year left till maturity*
= 96.27 x 0.09 x (40/360)
= 0.96

The price of the futures contract should, therefore, be

= *spot price* + *cost of carrying*
= 96.27 + 0.96
= 97.23

Source: F. R. Edwards and C. W. Ma, *Futures and Options*, McGraw Hill, 1992.

total transaction costs of passive portfolio management can turn out to be significant. Stock index futures offer a convenient way to move with the market at a significantly lower cost.

This does not imply, however, that stock index futures merely reduce transaction costs, and that they cannot be used to gain from price movements. Given the spot value of the index at the time when an investor enters into a contract, and the risk-free rate of return (i.e., yield on government bonds), the optimal futures price can be estimated using the *spot-futures parity* relationship. This relationship is based on the idea that, in an efficient market, inter-temporal arbitrage opportunities will not persist such that returns from any risk-free investment strategy should equal the returns

The use of such strategies, which attempt to exploit price mismatches in the futures market, is known as *index arbitrage*.

from a risk-free asset like a government bond [see *Box 5*]. Any mismatch between the theoretical and actual futures prices, therefore, implies a potential arbitrage opportunity, which can be exploited to enhance yields from an investment. The use of such strategies, which attempt to exploit price mismatches in the futures market, is known as *index arbitrage*.

How does a stock index futures market work? Let us take the example of the Standard and Poor's (S&P) 500 index futures which have a contract multiple of USD 500. In other words, if the S&P 500 index stands at 1000, each S&P 500 futures contract will be worth (1000 x 500 =) USD 500,000 and can, in principle, be used to hedge against price movements of equity valued at USD 500,000. If the closing value of the S&P 500 index on a day is 1000, against a closing value of 998 on the previous day, a gain of 2 points, then an investor with a long position gains (500 x 2 =) USD 1,000 and, correspondingly, an investor with a short position loses USD 1,000. Hence, USD 1,000 will be credited to the margin account of the investor with a long position, and this amount will be debited from the margin account of the investor with the short position.[23] The total gain/loss of an investor, of course, is the sum of the gains/losses on each of the trading days prior to the expiration of the contract.

How, therefore, can stock index futures be used for passive portfolio management involving low transactions costs? The relevant strategy involves creation of *synthetic stock positions* whereby an investor holds T-bills and takes long positions in the market for stock index futures. The intuition underlying the strategy can be best explained with an example. Suppose that an investor would like to invest USD 100 million in the equity market for a month. The current value of the S&P 500 index is (say) 1000, the one-month delivery price of the index is (say) 1004, and the yield on T-bills is (say) 0.4% per month. As indicated above, each S&P 500-index futures contract, therefore, is valued at USD 500,000. In other words, the investor requires 200 contracts for a total investment of USD 100 million in equity. If, now, (s)he takes a long position on 200 S&P 500 futures contracts, (s)he is liable to pay (200 x 500 x 1004 =) USD 100.4 million on the delivery date. Given the yield on T-bills, the investor can expect a risk-free return of USD 0.4 million if (s)he invests the USD 100 million in these government securities, and hence an investment in T-bills is sufficient to cover his/her (long) position in the futures market. If, now, the stock market outperforms expectations, such that the index exceeds 1004, then the investor will gain from the synthetic stock position, and if the stock market under-performs expectations then the investor will suffer losses from it.[24]

[23] Margins are settled on a daily basis. Typically, the margin for trade in an asset is equal to $\mu + 3\sigma$ when μ and σ are the mean and standard deviation respectively of the historical time series of the prices of the futures contracts. If the balance in the margin account falls below $\mu + 3\sigma$ after the portfolio has been marked to the market, the player faces a margin call from the futures exchange. (S)he then has to make the necessary payments to the exchange to restore the balance of the margin account to $\mu + 3\sigma$.

[24] If the spot value of the S&P 500 index on the delivery date is S_T, then the gains/losses of the investor will be given by

$$200 \times 500 \times (S_T - 1004)$$

BOX 5: Determination of stock/index futures prices

Futures prices are related to the prices of the underlying assets, physical or financial. Hence, if one can formulate a defined relationship between the price of the underlying asset and the futures price then it will be possible to estimate the futures prices, given values of the underlying assets. This relationship, as it exists, is known as the *spot-futures parity relationship.* It is based on the idea that since futures contracts yield risk free perfectly hedged positions, the returns from holding futures contracts should equal returns from other risk free assets (like government securities). Otherwise, there will exist arbitrage opportunities that are inconsistent, beyond the very short run, with efficient markets.

If the futures price on delivery is given by F_0, the price at the time of investment is S_0, and dividend paid (if any) is given by D, the returns to the aforementioned investor on the initial investment is given by

$$[(F_0 + D) - S_0] / S_0$$

which is risk free. Hence, in an efficient market where systematic arbitrage is not possible, this rate of return should equal the risk free rate of return (r_f). In other words,

$$[(F_0 + D) - S_0] / S_0 = r_f$$

or $$F_0 = S_0 (1 + r_f - d)$$

when d equals D/ S_0. If the delivery date of the futures contract is after t years, then the futures price will be given by

$$F_0 = S_0 (1 + r_f - d)^t$$

Source: Z. Bodie, E. Kane and A. Marcus, *Investments*, Irwin, 1993.

The payoffs from the synthetic stock positions, therefore, are similar to those that would arise out of actual holding of stocks by the investor, the important difference being that the transactions cost is lower for the former strategy than for the latter.

Options

Options are perhaps the simplest of the financial derivatives. There are two forms of options: call and put. If an investor buys a *call* option for (say) SBI shares, (s)he obtains the *right* to purchase a specified volume of the stock at a specified price, on or before a specified date. An investor who buys a put option for SBI shares, on the other hand, obtains a right to sell a specified volume of the stock at a specified price, on or before the specified date. The date and the price specified on an options contract are known as

The essential function of an options contract, therefore, is to provide insurance to the owner of the option.

. . . an options contract has to be purchased up-front, the price being known as the *premium*.

the *strike date* and the *strike price*. If an option is American in nature, it can be exercised on or before the strike date, while a European option can be exercised only on the strike date.[25]

The essential function of an options contract, therefore, is to provide insurance to the owner of the option. This feature of an options contract is a consequence of the fact that its owner has the *right* but not an *obligation* to exercise the contract. If, for example, the strike price for an European call option is INR 350, and the spot price for the underlying stock is INR 375 on the strike date, the owner of an options contract will exercise his/her option to buy the specified volume of the stock, and thereby profit from the difference between the strike and spot prices.[26^] If, however, the spot price of the stock is INR 340, then the option owner is not obligated to purchase the stock at the higher (strike) price, and may allow the option to lapse. Similarly, the owner of an European put option will exercise his/her right to sell a stock only if the spot price is below the strike price on the strike date. Otherwise, (s)he will allow the option to lapse. As such, it is exactly like a Mediclaim policy which is effected if and when the insured person faces adverse circumstances, i.e., if and when (s)he falls sick, and is allowed to expire unused otherwise.

Options Pricing

Like an insurance cover, an options contract has to be purchased up-front, the price being known as the *premium*. The price/premium of a call option can be computed using the *Black-Scholes* options pricing formula and its variations.[27] The formula is mathematically abstruse, and aims at estimating the call value as the present value of the option's payoffs, after adjusting for the probability of the outcome that the option will expire *in-the-money*.[28] While it is difficult to provide an intuitive interpretation of the Black-Scholes formula, it generally suggests that the price of a call option

- decreases with the strike price because the higher the strike price the lower is the probability that the option will be exercised;

[25] Options can be offered over the counter, as in the case of ICICI and IDBI bonds, which were offered with, call and put options, and such OTC options are typically non-tradable. There exist options, however, which are traded in exchanges and they include options on futures contracts, foreign exchange, and market indices.

[26] The owner of an American option, by definition, has a wider range of choice. However, it is easier to couch an argument in terms of a European option because it can be exercised on one pre-specified day. Hence, all illustrations and explanations in this paper will be put forward within the paradigm of European options.

[27] The Black-Scholes formula was constructed to estimate prices of European call options. Others like Robert Merton have extended/modified the formula to enable estimation of prices of American call options. Note that since American call options allow investors to exercise it *on* or *before* the expiration date, thereby allowing greater flexibility vis-à-vis the European call options, the former should, in general, be priced higher relative to the latter.

[28] An option is in-the-money when the risk-adjusted payoff from it is strictly positive. For example, the call for Reliance stock described above expires in-the-money, such that the owner of the option gains INR 25 per share by exercising the option on the strike date. In other words, if an option is in-the-money on maturity, it is exercised.

- increases with the time left for its expiration because the further away the strike date the higher is the probability that the option will be exercised;
- increases with the degree of volatility of the price of the underlying asset because the greater the historical variation in the price of the primitive asset the higher is the probability that the change in its price will be large, such that the option is exercised; and
- decreases with the interest rate because any payoff from the exercise of an option is realised in the future and, therefore, has to be discounted using the interest rate which can be used as a proxy for the rate of time preference.[29]

Once the price of a call option has been estimated using the Black-Scholes formula, the price of a put option can be computed using the *put-call parity* relationship. The relationship is the embodiment of the argument that an investor is accorded the same protection when (s)he buys a call option as compared with the situation when (s)he buys the underlying asset and simultaneously buys a put option. The cost of the former strategy, therefore, equals the price of the call option and the value of the safe asset that the investor must hold to purchase the underlying asset should (s)he exercise the call option. The cost of the latter strategy, on the other hand, equals the price of the put option and the price of the underlying asset for which the put option is purchased. The costs these alternative strategies can, of course, differ, given the strike prices for the two options, the spot price of the asset, the risk-free interest rate (required for discounting future payoffs), and the prices of the options themselves. However, if the cost of any one strategy is lesser than that of the other then all investors will opt for that strategy and the price for the corresponding options contract will rise till the "gains" disappear. Hence, in equilibrium, the costs of the two strategies should be the same.[30] This put-call parity condition can, therefore, be expressed as an algebraic equation which relates the price of a call option of an asset with a put option of the same maturity. Hence, once the price of a call option has been estimated, given the values of the strike and spot prices, and the risk-free interest rate, the price of the put option can be easily calculated.

Hence, in equilibrium, the costs of the two strategies should be the same.

[29] Discounting is an integral part of project evaluation. Let the payoff (INR P_a) from a project A be instantaneous. Let the payoff (INR P_b) from a project B be realised 1 year into the future. An investor cannot compare P_a with P_b in order to decide which project is more profitable, given that the payoffs are realised at two different points in time. In other words, one has to how much the two projects yield after the same time frame. Now, the payoff from project A will be $P_a(1 + r)$ after 1 year, when r is the one-year interest rate. The investor, therefore, should compare between $P_a(1 + r)$ and P_b. Alternatively, (s)he can compare between P_a and $P_b/(1 + r)$, when $P_b/(1 + r)$ is the discounted value of the payoff that will be realised in the future. The inverse relationship between the interest rate and the discounted value of a payoff in the future is obvious.

[30] Indeed, any violation of the put-call parity condition indicates that one or both the relevant options have been mispriced, such that there exists an opportunity to earn "arbitrage" profits by exploiting the mismatch.

Further, investors can use one or more call and put options with different strike prices in conjunction to obtain a wide array of payoffs, and the better known of such strategies are known as *straddles, collars* and *spreads*.

Investment Strategies

Apart from plain vanilla call and put options on financial securities, options contracts are available for market indices, futures contracts and foreign currency contracts. For example, an investor can purchase a call option for the S&P 500 index. If the strike price of the call option is USD 950 and the spot value of the S&P 500 index is 940 when the option is exercised, the owner of the call option will receive USD 10 times the *contract multiplier* of 500, i.e., (s)he will receive USD 5,000.[31] Further, investors can use one or more call and put options with different strike prices in conjunction to obtain a wide array of payoffs, and the better known of such strategies are known as *straddles, collars* and *spreads*. These strategies aim at limiting the possible extent of losses, thereby significantly reducing the risk associated with an investment.[32] The fallout of such strategies, however, is that the investors/issuers concerned also limit the extent of profit they can earn from movements in the price of the underlying asset, an outcome which is in agreement with the conventional wisdom that low risk is associated low return. Issuers of securities too can use combinations of call and put options to hedge against future movements in asset prices and interest rates.[33] A detailed discussion of these strategies lies outside the scope of this paper.

[31] Typically, options (as well as futures) contracts for market indices have a contract multiplier. The values of the multipliers are determined by the exchange in which the derivatives' contracts are traded, and involve a careful balancing of two considerations. On the one hand, too large a multiplier is undesirable because it exposes the owner of each contract to a large financial risk. On the other hand, too small a multiplier is will prove to be inefficient because too many contracts will then be required have to be purchased or entered into to take a given financial exposure.

[32] A *collar*, for example, is a combination of one call and one put option. Suppose that the spot price of an asset is INR 90. An investor who is in possession of this asset might want to protect his/her investment by buying a put option which defines the minimum price (say, INR 80) that (s)he will get for each unit of it. However, purchasing the put option will entail an up front expense which the investor might not be willing to bear. (S)he can, in such an event, recover his/her cost (of purchasing the put option) by selling a call option with a strike price (say, INR 100) which is higher than the spot price (say, INR 90) of the underlying asset. If, therefore, the price of the asset falls below the spot price, the maximum loss that the investor can incur is INR 10. On the other hand, even if the purchaser of the call option written by the investor decides to exercise it, after the price of the asset exceeds INR 100, the investor will still gain by INR 10.

[33] One such product, the Liquid Yield Option Note (LYON), was first issued by Merrill Lynch in 1985, on behalf of one of its clients. The *zero coupon* bond was convertible into equity at the discretion of the investor at a pre-determined bond-equity ratio, callable at the discretion of the issuer, and put-able at the discretion of the investor. In other words, the product provided protection to an investor against price reductions, and assured him/her of capital gains if the share prices of the issuer increased in the future. At the same time, the issuer was in a position to recall the bonds in the event a fall in the market interest rate rendered refinancing of these bonds profitable. In the final analysis, the "insurance" package enabled the issuer to borrow at low interest rates by reducing by risk of the investors, and, at the same time, offered protection to the former by enabling him/her to take advantage of any further reduction in the interest rate in the future.

Hedge Ratio

An analysis of options contracts, however, will remain incomplete if it does not include a description of the *hedge ratio* of an option, also known as the option's *delta*. Let the spot value of a share is INR 100, in a market which offers an investor an alternative in the form of a bond which offers a risk free coupon rate of 8%. For reasons of simplicity, assume that only two states are possible in the future: a good state in which the value of the share will be INR 110, and a bad state in which the value of the share will be INR 90. Suppose that a call option with a strike price of INR 100 is also available in the market, and that the option expires after one year. An investor, therefore, has two alternatives. (S)he can either purchase one call option, or (s)he can buy some combination of shares (e) and bonds (b). In an efficient market, the payoffs from the two strategies will be the same. It can be shown that the payoff from the call option can be replicated if the investor buys 0.5 of the share, and *short sells* 0.4166 of the bond (i.e., borrows INR 41.66 at the risk-free rate).[34]

Suppose that the investor purchases 0.5 of the share (and borrows INR 41.66). Hence, if the share price changes by INR 1, the value of the portfolio will change by INR 0.5. But the payoff from this strategy should equal the payoff from the purchase of the call option, and hence the INR 1 change in the share price should change the payoff from the call option by INR 0.5. This fraction (i.e., 0.5), which is the ratio of the change in the payoff from the option to the change in the payoff from the share price, is the hedge ratio or *delta* of the option.

Why is a hedge ratio an important consideration? Suppose there are two portfolios A and B, A being composed of 700 call options on XYZ shares, and B being composed of 200 call options and 400 shares of XYZ. Suppose that the hedge ratio is 0.5. In that case, an INR 1 change in the share price of XYZ will result in a change in the payoff from each call option by INR 0.5. The total change in the value of portfolio A will then be (700 x 0.5 =) INR 350, and the total change in the value of portfolio B will be (200 x 0.5 + 400 x 1 =) INR 500. In other words, portfolio B is more sensitive to changes in the share price of XYZ than portfolio B. Since price sensitivity is a key factor in the determination of portfolio choice, the importance of the delta cannot be overemphasised.

Since price sensitivity is a key factor in the determination of portfolio choice, the importance of the delta cannot be overemphasised.

[34] Suppose that *e* and *b* respectively are the numbers of shares and bonds purchased. Hence, in the good state, we should have

$110\,e + 108\,b = \text{INR } 10$

and in the bad state, we should have

$90\,e + 108\,b = \text{INR } 0$

when INR 10 and INR 0 are the payoffs from the call option in the good and bad periods respectively. It can be verified that the equations are simultaneously satisfied when $e = 0.5$ and $b = -0.4166$, the negative sign of *b* suggesting that the bond has to be (short) sold.

. . . it is not evident that while these products reduce uncertainty at the individual investor's level, that they will necessarily reduce uncertainty at the aggregate market level.

Concluding Remarks

It is evident that financial derivatives can be used by individual investors to hedge against sudden or unexpected market movements and, to that extent, the usefulness of these products can hardly be questioned. However, it is not evident that while these products reduce uncertainty at the individual investor's level, that they will necessarily reduce uncertainty at the aggregate market level. In particular, two important issues need to be addressed.

First, one has to examine the potential impact of these products on the volatility of equity prices, interest rates and exchange rates. The importance of this issue arises from the fact that a high degree of volatility is typically associated with uncertainty that can give rise to perverse expectations in the minds of the investors. As highlighted by the recent experience involving the global currency and stock markets, it is such expectations, and not necessarily pessimism about the *fundamentals*, that precipitate crises in financial markets.[35]

Second, one has to take cognisance of the fact that, in the recent past, derivatives trading has been associated with major financial disasters involving major market players like Barings, Sumitomo and Daiwa. The common wisdom is that these crises were a consequence of some intrinsic property of derivatives that render trades involving these instruments very risky. On the other hand, the crises may have been a consequence of the severe informational asymmetry that exists between the designers of derivatives and the end-users, and also between individual traders and the market (or regulatory authority) at large. This is likely to be particularly true under circumstances where the derivatives products in use are exotic, and thereby more difficult to understand, as opposed to plain vanilla products like simple options and forwards contracts. A comprehensive view of financial derivatives should also include an analysis, which attempts to discover which of these explanations is more consistent with the actual observations.

Such analyses, however, require the development of an appropriate analytical paradigm, and have to be supplemented and augmented by empirical evidence from markets that have been witness to significant trading in financial derivatives during the last two decades. Hence, although an appropriate analysis will not be divorced from the description of the products included in this paper, the former will address regulatory and informational issues on which the description do not necessarily have a direct bearing. As such, this analysis lies outside the scope of this paper, and is important and substantial enough to give birth to a paper in its own right. That is indeed the mandate of the second part of (or sequel to) this paper.

[35] M. K. Rakshit, "Learning and Unlearning from the Thai Currency Crisis," *Money & Finance*, 3: 24-46, September 1997.

REFERENCES

Bank for International Settlements, (1996) *Central Bank Survey of Foreign Exchange and Derivatives Market Activity 1995*, Basle.

Bhaumik, S. K., (1997) "Stock index futures in India: Does the market justify its use?" *Economic and Political Weekly*, XXXII(41): 2608-2611.

Bodie, Z., E. Kane and A. Marcus, (1993) *Investments*, Irwin.

Edwards, F.R. and C.W. Ma, (1992) *Futures and Options*, McGraw Hill.

General Accounting Office, (1994) *Financial Derivatives: Actions Needed to Protect the Financial System*, Report no. GAO/GGD-94-133.

Kohn, M., (1994) *Financial Institutions and Markets*, McGraw Hill.

Rakshit, M.K., (1997) "Learning and Unlearning from the Thai Currency Crisis," *Money & Finance*, 3: 24-46.

Rivera-Batiz, F. L. and L. A. Rivera-Batiz, (1994) *International Finance and Open Economy Macroeconomics*, Macmillan Publishing Company.

Shah, A. and S. Thomas, (1997) "Securities Markets: Towards Greater Efficiency," *India Development Report*, Oxford University Press.

Sharpe, W., G.J. Alexander and J.V. Bailey, (1995) *Investments*, Prentice Hall.

Streit, M.E., (1983) *Futures Markets: Modelling, Managing and Monitoring Futures Trading*, Basil Blackwell.