BANK FOR INTERNATIONAL SETTLEMENTS

Compendium of annexes to the report on

MACROECONOMIC AND MONETARY POLICY ISSUES RAISED BY THE GROWTH OF DERIVATIVES MARKETS

Prepared by individual central banks participating in a working group established by the Euro-currency Standing Committee of the central banks of the Group of Ten countries

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MACROECONOMIC AND MONETARY POLICY ISSUES RAISED BY THE GROWTH OF DERIVATIVES MARKETS

Annexes prepared by individual central banks

Annex I

Effects of derivatives products on the underlying markets: a survey of recent empirical evidence

Banca d'Italia

1. Introduction

In the limiting case of market completeness and perfection the introduction of derivative products does not alter the equilibrium conditions of the underlying markets. In general, the introduction of derivatives can affect to a varying degree the speed with which prices adjust to new information, modify the depth and width of the markets and affect assets' prices level and volatility.

The increasing availability of intraday data on prices and transactions has produced a growing body of empirical evidence on the relationships between derivatives (mainly options and futures) and spot prices on both stock and bond markets. The vast majority of this evidence has been collected on the American markets, which offer a longer record of derivatives trading on organised exchanges and a greater availability of structured data-sets. Such contributions can be grouped under the following main headings:

- effects of derivatives on price volatility;
- effects of derivatives on price levels;
- other effects on market-microstructure (bid-ask spreads, trading volumes, feedback relationships).

A brief review of the empirical evidence in those three areas is provided in the following pages. Where clearcut results are not available, an attempt is made to account for the failure to detect a clear relationship between spot and derivatives markets. The focus of the review is on market-related variables and not on the effects of derivatives on the behaviour of financial intermediaries: such aspects as the impact on bank lending activity have therefore not been considered here.

2. Effects on the volatility of the underlying assets

The available empirical evidence seems to support the notion that the introduction of derivatives has affected the volatility of underlying asset prices, although the effects associated with futures and option contracts are different.

In particular, analysis conducted on the American stock markets shows that **option contracts have exerted a beneficial effect in terms of reducing volatility.** The empirical evidence relies on the analysis of volatility changes before and after the introduction of option contracts and volatility differences between optioned and non-optioned stocks.

Among the work using the first approach, Hayes and Tennenbaum (1979) and Ma and Rao (1986) find a reduction in volatility after the start of the option market for a sample of optioned stocks. Ma and Rao, in particular, find a reduction in the volatility of high risk stocks with beneficial effects for volatility in the overall market. Whiteside, Duke and Dunne (1983) reach the same conclusion, but do not agree on the timing: statistical changes in volatility would not occur immediately after the introduction of the option contacts but would be perceivable with a one-year lag.

In the second case, a cross-section comparison between optioned and non-optioned stocks allows Damodaran and Lim (1991) to show that optioned stocks display significantly lower volatilities than those of non-optioned stocks. Optioned and non-optioned stocks are chosen so that their characteristics match (betas, firm size and class).

Klemkosky and Maness (1980) also find that optioned assets' systematic risks (as measured by betas) have been altered by the introduction of derivatives. However Damodaran and Subrahmanyam (1992) report that more recent evidence does not support the impact of options on betas, in addition to that on the idiosyncratic component of asset volatility.

The impact of futures contracts[1] on assets' price volatility is more debated and controversial. In general, the number of futures contracts provides a more limited number of initial listing events compared with options, and this makes it difficult to

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[1] Futures, unlike options contracts, do not help to complete the markets, since their price is a static combination of existing asset prices. Bond futures give the same information as spot bond prices, since the maturity of the deliverable contract in general does not exceed that of the bond. As a matter of fact, interest rate futures may usually be replicated by the existing yield curve, while stock index futures are even more trivially replicated by the portfolio of securities included in the basket. Their contribution is primarily that of reducing the transaction costs associated with trades on the spot markets.

isolate and measure the effects of their introduction. Despite this limitation, the effects appear to be more clearcut for markets where informational asymmetries among intermediaries tend to be wider.

In particular early analysis, dating back to the sixties (Working, 1960), and more recent works (Ma, Dare and Donaldson, 1990), show that **futures on commodities seem to reduce price volatility**. It is not clear if their contribution to volatility reduction is due to a more extensive use of hedging or to the greater speed with which future prices incorporate information and revert to equilibrium.

The role performed by financial futures appears more uncertain. Futures on stocks were analysed in an early paper by Stoll and Whaley (1987), who found an increase in market volatility of stocks included in the index basket the day of contract expiration. Harris (1989) and Damodaran (1990), using the same S&P 500 index future, also find that stocks included in the index have a significantly higher volatility than those not included; however, they find different effects of futures listings on the betas of the stocks belonging to the basket (null for Harris and positive for Damodaran). For the UK market, Robinson (1993) finds that, making use of conditional rather than unconditional measures of volatility, the FTSE-index volatility has experienced a reduction after the introduction of futures trading.

Unlike the previous case, futures on bonds, especially treasury bonds, seem to be associated with some volatility reduction. Given the limited relevance of information asymmetries in this market this appears to be due to market liquidity enhancement. A contribution in this sense may be provided by futures' lower transaction costs.

This is particularly true for stock index futures, since the alternative policy of buying all the bonds in the basket would carry with it very high transaction costs[2] and by their leverage, which reduces the resources needed to take positions in the market.[3] With reference to the Italian T-bond market, Esposito and Giraldi (1994) found that the introduction of futures trading on the BTP contract reduced the volatility of the underlying market. Studies on the US government and mortgage bond market (Froewiss

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[2] This is particularly true for stock index futures, since the alternative policy of buying all the bonds in the basket would carry with it a very high transaction costs. This advantage is less relevant for bond futures, even though it may be observed that, after the introduction of futures, speculative trading tends to concentrate in the derivative market, with consequent erosion of the liquidity of the underlying.

[3] In general, a "perfect" market is associated with infinite liquidity and no transaction costs whatsoever. We must remember that the concept of perfect markets is not usually defined in financial theory; in general, it is associated with frictionless markets. In any case, a market might well be perfect but not complete.

(1978), Simpson and Ireland (1982), Bortz (1984) and Edwards (1988)) found that futures trading either has no effect or stabilises the underlying markets.

As already outlined, the inconsistent evidence of derivatives' impact on price volatility can at least partly be due to the differing nature of underlying assets. Options and commodity futures owe their volatility smoothing effect to the potential informational asymmetry among intermediaries, which the derivatives themselves help to reduce (Damodaran and Subrahmanyam, 1992). By contrast, products based on index performance (mainly financial futures) are less likely to be affected by confidential information on the assets that form the index.

3. The effects on the price level of the underlying assets

There is a presumption that derivatives increase the liquidity level of the markets, lowering the return required by the market and increasing its equilibrium price. Amihud and Mendelson (1986,1989,1990) show that in the American financial markets assets with the same level of risk but different liquidity may have different yields.

With regard to <u>options</u>, empirical evidence seems to confirm this theory, finding abnormal average cumulative returns around the period when options are first listed (De Temple and Jorion, 1990). In particular, while the "announcement effect" seems to be small or extremely limited (Conrad, 1989), option listing itself appears to affect the price level of the underlying assets. The introductions of call options would increase price level, while put options would reduce it (Damodaran and Lim, 1991): payoff asymmetries could explain these results. In the case of put contracts, they found that listing depresses prices, due to the possibility offered by futures contracts to bypass short sales constraints on the underlying assets, thus allowing bearish expectations to gather force (Figlewski, 1981).

As already mentioned, the limited number of <u>futures</u> listing events makes it difficult to measure the effects on mean returns unambiguously. An effort to detect the impact of futures contracts on Treasury bond returns was made by Citanna and Rovelli (1991), who analysed the French market and found a reduction of term premia in the yield curve after the listing of the future on the OAT. This finding is consistent with an improvement in risk sharing, made possible by futures trading between agents with different degrees of risk aversion (hedgers and speculators).

4. The effects on market microstructure

Theory suggests three additional effects of derivatives listing that we may group under the heading of microstructure effects: the speed with which new information is incorporated in market prices should be increased, the volume of transactions in the underlying markets should change and the bid-ask spread should narrow. In fact, when information is embedded rapidly in prices, asymmetric information quickly tends to vanish with positive effects on bid-ask spreads and on trading volume.

Damodaran and Lim (1991) find that option listing affects information production by increasing market focus on the optioned stocks (number of analysts following a particular asset, frequency of articles). **The greater speed with which information is incorporated in prices is documented for <u>options</u>** markets, where Jennings and Stark (1986) and Damodaran and Lim (1991) found that prices of optioned stocks adjust more rapidly to earnings reports than those of non-optioned stocks. **However, the direction of the feedback relation between option and spot market prices** is not uncontroversial: Manaster and Rendlemam (1982) and Anthony (1988) found evidence of impulses moving from option to spot prices, while Stephan and Whaley (1988) documented a relationship going in the opposite direction. With reference to the 1987 crash, Bates (1991) found that out-of-the-money puts became unusually expensive just before the market collapse, giving support to the fact that spot prices were anticipated by option prices.

Clear evidence of the existence of feedback from derivative prices to the spot market, in addition to contemporaneous feedback, is provided by studies of the intraday behaviour of spot and <u>futures</u> markets. Kawaller, Koch and Koch (1987) and Stoll and Whaley (1990) show S&P 500 futures leading the S&P 500 index by several minutes; Kawaller, Koch and Koch (1990, 1993) observe that the relation between contemporaneous cash and futures prices becomes stronger as futures price volatility increase's, indicating that higher volatility levels generate faster information processing and more closely matched movement of futures and stock markets; they also find a positive correlation between volatility and futures trading activity. Chan (1992) finds that the asymmetric lead-lag relationship between futures prices and those of the stock index components is strengthened when more stocks move together, suggesting that the futures market is the main source of market-wide information.

Preliminary evidence of the lead-lag relationship between futures and spot prices on the bond market is provided by Angeloni, Drudi and Majnoni (1994), who analyse the intraday price behaviour for the Italian market in the period 1992-94. Similarly to the stock markets, they find clear evidence of feedback from futures to spot prices and very weak signs of feedback in the opposite direction.

Econometric studies do not reveal a significant effect on the volume of trade. In the case of the introduction of options, for instance, Bansal, Pruitt and Wei (1989) find that trading volume increases after option listing but only for a short period around the listing date. Damodaran and Lim (1991) find a small effect on market-adjusted volumes and Skinner (1989) reports the disappearance of volume effects after the seventies: Damodaran and Subramanyan (1992) interpret this evidence as a sign that the introduction of derivatives did not entice speculators into the underlying markets.

In general, **the literature seems to agree on the drop in the bid-ask spreads induced by the introduction of derivatives.** Bid-ask spread for securities tend to be smaller in the presence of derivatives written on them as a consequence of the rise in overall liquidity. Evidence of this effect is provided with reference to optioned stocks traded on American official markets by Neal (1987), Fedenia and Grammatikos (1989) and Damodaran and Lim (1991). Damodaran and Subrahmanyan (1992) suggest that the apparently contradictory evolution of bid-ask spreads and trading volumes may be due to a change in the composition of traders on the spot markets following the introduction of trading in derivatives.

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Dynamic hedging

Principles of delta portfolio management and consequences for the volatility of asset prices

Banque de France

1. Definition of delta

One of the basic insights of Black and Scholes' paper on the pricing of options and corporate liabilities is that it is possible to construct an arbitrage portfolio, e.g. short options and long underlying assets, in such a way that changes in the price of the call options are exactly offset by changes in the price of the underlying asset. The ratio of the number of units of the underlying asset bought to the number of call options sold in order to obtain the arbitrage portfolio is usually called delta.

The delta[1] measures the sensitivity of the value of the call option to small changes in the price of the underlying asset, and can be expressed algebraically as follows:

$$delta = \Delta = \frac{change\ in\ c}{change\ in\ s} \quad (0 < delta\,(call) < 1)$$

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[1] In the standard Black and Scholes model the delta of a call (the delta of a put is equal to the delta of a call - 1) corresponds to the probability $N(d_1)$ that a normally distributed random variable x will be less than or equal to d_1, where

$d_1 = (\log (P/PV(EX)/ \sigma \sqrt{t}) + (\sigma \sqrt{t} / 2)$
P = price of the underlying asset now
EX = exercise price of the call; PV(EX) is calculated by discounting at the risk free rate:
$PV(EX) = EXe^{-rft}$
σ = standard deviation per period of the (continuously compounded) rate of return on the underlying asset
t = number of periods to exercise date.

The interpretation of $N(d_1)$, i.e the delta of the call presents some difficulties. It can be shown (see Lars Type Nielsen: "Understanding N(d1) and N(d2) : Risk-Adjusted Probabilities in the Black-Scholes Model", INSEAD, March 1992) that the expected value, computed using risk-neutral probabilities, of receiving the underlying asset at expiration of the option, contingent upon the option finishing in the money, is $N(d_1)$ multiplied by the current stock price and the riskless compounding factor. Thus, $N(d_1)$ is the factor by which the present value of contingent receipt of the underlying asset exceeds the current underlying asset price.

This notion of a delta of a call can be generalised to any portfolio consisting of the underlying asset, options on the underlying asset, and debt or deposit: delta measures the sensitivity of the portfolio value to small changes in the value of the underlying asset. The values of the delta of these financial assets are the following:

underlying asset = 1

debt/deposit = 0

call = $N(d_1)$ (according to Black-Scholes)

put = $1-N(d_1)$

Thus for a portfolio made of x calls, y puts and z underlying assets the delta is equal to x delta (call) + y delta (put) + z.

2. Examples of portfolio management using delta

Several portfolio management strategies are based on the use of the delta of assets. The following two examples are often said to contribute to fuelling asset price volatility, especially during periods of stress.

(a) Delta hedging

Delta hedging means balancing a portfolio so that its delta is zero. As a result, the portfolio value will be insensitive to small changes of the underlying asset value. A delta neutral portfolio behaves in the short run like a riskless asset.

For instance, a seller of options who wants to immunise his position against variations of the price of the underlying asset will construct the arbitrage portfolio of Black and Scholes, i.e. will buy, if he sold calls, and sell, if he sold puts, units of the underlying asset in order to have a ratio of the number of units of the underlying asset to the number of the options equals to the delta of the latter. He will hold therefore a portfolio which has the same payoff as a riskless asset.

To illustrate this point, let us take the example of a call option on 50,000.00 USD with a delta of 0.65; it is equivalent to a cash position of 0.65 x 50,000.00 USD = 32,500.00 USD. The seller of such an option is a potential seller of 50,000.00 USD. If he wishes to delta hedge his position he will buy 32,500.00 USD on the cash market to diminish his instantaneous exchange rate risk. The table below provides examples of delta hedging with options out, at and in the money.

Strike price of the call option USD/FRF	Spot rate	delta	hedge undertaken for a nominal amount of 50,000.00 USD
5.50	out of the money 5.30	$0 < \Delta < 0.50$ $\Delta = 0.20$	the seller of the call buys 10,000.00 USD.
5.50	at the money 5.50	$\Delta = 0.50$	the seller of the call buys 25,000.00 USD.
5.50	in the money 5.80	$0.50 < \Delta < 1$ $\Delta = 0.90$	the seller of the call buys 45,000.00 USD.

However, a portfolio is delta hedged over just an instant notably because the delta of the options fluctuates with the price changes of the underlying asset, especially for options at the money, or close to the money. Therefore the seller of options has to dynamically hedge, that is to say he has to adjust, in theory constantly, in practice at regular time intervals, the number of underlying assets he holds in his arbitrage portfolio, in a proportion given by the changes in value of the delta of the options he sold. **It turns out that this leads to selling the underlying asset when its price moves down and buying it when its price moves up.**

As an example, consider that a seller of a call option (maturity = September; strike price = 116.00) on the "Matif Notionnel" September contract which is currently traded at 117.00 can delta hedge his position if he buys 0.557 units of the Notionnel September (0.557 is the current value of the delta of the call). If the price of the Notionnel rises to 119.00, the delta of the call becomes 0.652 and the portfolio manager must buy additional units of Notionnel contracts for his short position in calls to remain delta hedged. The number of additional units to buy is given by the difference between the new and the former value of the delta of the call (0.652 - 0.557 = 0.09). Conversely, if the price of the Notionnel falls to 116.00, the delta of the call becomes 0.520 and the portfolio manager has to sell 0.037 units of Notionnel contracts to remain delta hedged.

(b) Portfolio insurance

Several techniques can be implemented to protect a portfolio against an adverse movement of the price of the assets in the portfolio and at the same time benefit from a favourable evolution of the price of these assets. One of them is based on the creation of **synthetic options**. In the case of stocks this technique may consist of constructing a portfolio made of:

- either stocks and synthetic puts on the stocks held; or
- zero coupon bonds and synthetic calls on an index.

Example: on 13th June 1994, we construct a portfolio of stocks called X, whose current value is 880.00 FF (S) that we insure against a fall of the stock price below 880.00 FF up to the end of September. In order to achieve this result we buy synthetic puts, with a strike price of 880.00 FF and of maturity September 1994. On the MONEP the value of the put is 47.00 FF (P) and its delta (deltap) is equal to -0.50. It can be shown that the buying of synthetic puts ends up in constructing an initial portfolio which is a multiple of:

1 + deltap X stocks = 0.50 stocks with a value of 440.00 FF

- P - (deltap) S Treasury bills = 487.00 FF of treasury bills

Therefore the value of this portfolio is a multiple of 927.00 FF (i.e., 440.00 FF of X stocks and 487.00 FF of Treasury bills).

As for the delta hedging, this strategy implies a dynamic revision of the composition of the portfolio which will lead to selling the underlying asset when its price moves down and buying it when its price moves up.

If for instance, the value of the stock moves from 880.00 FF to 885.00 FF, this evolution implies that

- the delta of the X put moves from - 0.50 to - 0.40;
- the value of the put decreases from 47.00 FF to 45.50 FF;
- the value of the portfolio increases as a multiple of 3.50 FF (this increase is equal to the difference between the increase in the value of the stock of 5.00 FF and the diminution of the value of the put -1.50 FF).

With these new parameters, the overall portfolio becomes a multiple of:

- 1 + (deltap) X stocks = 0.60 stocks with a value of 531.00 FF

- P - (deltap) S francs of Treasury bills = 399.50 FF

The former composition of the portfolio being a multiple of 0.50 X stocks (value 440.00 FF) and 487.00 FF of Treasury bills, the manager has to:

- buy a multiple of 0.10 X stocks;
- sell a multiple of 87.50 FF of Treasury bills.

Annex III

Portfolio Insurance

Federal Reserve Bank of New York

In mid-October 1987, US stock prices fell with unusual speed and magnitude. The Dow Jones Industrial Average declined from a closing level of 2505 on 13th October to a close of 1738 on 19th October. Two-thirds of this drop occurred on 19th October alone. Seven years later, the Brady Commission's judgement that derivative instruments did not trigger the stock market crash is widely accepted. The market's decline appears to have been precipitated by a number of economic fundamentals, including the announcement on the morning of 14th October of a higher than expected merchandise trade deficit, which contributed to the market's concern about a jump in interest rates. However, portfolio insurance trading in stock index futures contracts may have accelerated the pace of the stock market's decline. Portfolio insurance strategies prompted investor selling as the market began to drop, with additional sales being made as the market sank further. Due to arbitrage linkages between the stock index futures market and the underlying stock market, selling in one market was quickly transmitted to the other. During the worst of the crash, however, these two markets decoupled, as large discrepancies between the prices of futures and stocks persisted.

The mechanics of portfolio insurance

Portfolio insurance is a specific method of dynamically hedging a diversified equity portfolio against market movements that was used widely by large institutional investors during the mid-1980s. Portfolio insurance involved the use of stock index futures to mimic a protective put option on an equity portfolio and establish a floor below which its value could not fall. When the stock market declined, investors sold stock index futures contracts on their underlying portfolios in order to protect against the effects of further declines in market prices. In essence, portfolio insurers traded the market in an option-like fashion in order to delta hedge their underlying portfolios.

As with other forms of delta hedging, the purpose of portfolio insurance is to reduce exposure to price risk by redistributing the portfolio's assets between risky and risk-free instruments. The index futures market offered investors a cheap way to trade stocks, and enabled many investors to pursue portfolio insurance strategies. Portfolio insurance could in theory have been accomplished without stock index futures. In the mid-1980s, however, portfolio insurers typically traded stock index futures, rather than stocks or index options, in order to delta hedge their equity portfolios. While delta hedging could have been accomplished by selling stocks and investing the funds received in money-market instruments as market prices fell, the high transaction costs associated with frequent trades in a large number of stocks rendered this approach relatively inefficient. Delta hedging could also have been achieved by purchasing put options on stock indices. However, index futures were preferred to index options because they were available for a greater range of stock indices and were not subject to position limits.

Failure of portfolio insurance

Investors following portfolio insurance strategies acted on the assumption that the futures market was infinitely liquid. While this assumption was valid from the perspective of any single investor acting alone, it did not hold up when many large investors rushed to one side of the market. However, heavy selling in the futures market pushed futures prices to a discount to stocks, creating a profit opportunity for index arbitrageurs, who responded by buying futures and selling the underlying stocks. Index arbitrage trading transmitted general selling pressure in the futures market to individual stocks in the cash market, and prompted further sales of futures by portfolio insurers. In this way, portfolio insurance trading drove a cycle of selling in the cash and futures markets that gained momentum in mid-October 1987.

Portfolio insurance broke down during the October 1987 market crash, when many large investors simultaneously responded to declines in equity prices by selling stock index futures, creating a hedging overhang. Portfolio insurers' sales increased substantially above normal levels during the week preceding the crash, as stock prices began to drop and investors rushed to hedge against the market's decline. However, portfolio insurers were unable to keep pace with the level of selling dictated by their hedging models. By the market's opening on 19th October, portfolio insurers had sold less than a third of the $12 billion stock-equivalent amount of futures that their models indicated should have been sold. This created a hedging overhang of $8 billion, as compared to daily trading volume on the New York Stock Exchange, which had averaged $7.5 billion over the summer of 1987.

On 19th October, as the market fell, the stock market's infrastructure was overwhelmed by massive trading volume. By 10 a.m., $1 billion in sell orders had been loaded into the NYSE's DOT automated order execution system, straining the system and causing execution delays. In addition, since some specialists did not open trading in their stocks until later in the day, stock indices reflected some prices that were out of date. The inability to execute trades quickly and the lack of reliable stock price information blocked the access of index arbitrage traders to the stock market. When effective index arbitrage trading became impossible, the cash and futures markets decoupled and futures went to a discount to stocks. As futures prices remained below spot levels, futures sales became a relatively expensive way to delta hedge equity positions, and portfolio insurers took large losses. Many portfolio insurers were unable to execute their strategies; some retreated from the market entirely until after the market had bottomed out midday on 20th October.

Annex IV

Rising long-term interest rates and the trading of derivatives in Japan since the beginning of 1994

Bank of Japan

1. The causes of rising long-term interest rates

Japanese long-term interest rates continued to decline even after the seventh cut in the official discount rate (ODR) in September 1993, but they began to rise after bottoming out in early January: the yield of the benchmark Japanese Government Bond (JGB) hit its lowest at 2.97% on 7th and 10th January, but since then it has risen by nearly 1.6 percentage points by mid-September (Chart 1).

The recent rise in long-term interest rates can be attributed chiefly to the following two factors: (a) the correction of the expectations, held until early January of 1994, that the ODR would be further reduced; (b) a subsequent improvement in the Japanese economic fundamentals.

(i) Behaviour of long-term interest rates through the beginning of the year

From the autumn of 1993, pessimistic sentiment about the course of the economy spread in the markets because of the possible depressing effects of the yen's appreciation and of unfavourable weather conditions. Consequently, stock prices accelerated their declines (the Nikkei 225 average temporarily fell to the ¥16,000 level in December from the ¥20,000 level of October), giving rise to greater expectations that another ODR cut was forthcoming. These expectations of lower short-term interest rates appeared to lead the decline in long-term interest rates at that time.

The implied forward rates estimated from long-term interest rates generally shifted downward to below the level of those prevailing on the day of the seventh ODR cut until early January (Chart 2), when long-term interest rates reached bottom. This indicates that the level of long-term interest rates at that time incorporated the expectations of an additional ODR cut of more than 0.5 percentage points.

(ii) Rebound in long-term interest rates

In January 1994 great concern was widely expressed about the market conditions of JGBs because of the announcement of a tax cut and the implementation of a supplementary budget, and stock prices began to rise rapidly. (Seen in retrospect this was a result of the turnaround in real economic activities.)[1] These changes diminished the ODR cut expectations and triggered the sharp rise in long-term interest rates. By the end of January, the benchmark JGB yield reached 3.54%, showing a 0.57 percentage point increase over the bottom.

After February, expectations of another ODR cut waned further because of the release of economic indicators suggesting an improvement in economic activity since January, causing a further rise in long-term interest rates. (The benchmark JGB yield reached 3.9% by the end of March.) During this period, the implied forward rates shifted upward, and by the end of March their profile had returned to the shape prevailing at the time of the seventh ODR cut, suggesting that any expectations of an additional ODR cut had been completely eliminated by this time.

In April and May long-term interest rates stabilised, but they then began to rise again because economic statistics released towards summer more clearly indicated the high probability of economic recovery (contrary to earlier fears that the economy would slow after the new fiscal year started in April). The benchmark JGB yield is about 4.6% in mid-September (1.6 percentage points increase over the bottom).

(iii) Influences of foreign interest rates

It has been said that Japan's long-term interest rates were influenced by the rise in US long-term interest rates from the latter half of 1993. However, the long-term interest rates of Japan and the US have not really been "coupled". Instead, it would be more consistent with reality to view their movements as reflecting the differences in the timing and speed of economic recovery in the two countries. Although further research is needed to investigate international "coupling" and/or "de- coupling " of long-term interest rates, this view is supported by the fact that when US long-term interest rates were beginning to rise last fall, Japan's long-term interest rates were on a declining trend (Chart 1; long-term interest rates bottomed out in October 1993 in the United

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[1] The Nikkei 225 average, at the ¥17,000 level at the beginning of the year, recovered to reach the ¥20,000 mark on 31st January for the first time in about 3 months.

States, in January 1994 in Japan). Moreover, it has already been shown that factors specific to Japan were responsible for Japan's long-term interest rates rise.

2. Derivatives trading under rising long-term interest rates

It has been argued that the rise in long-term interest rates since the beginning of 1994 was mainly triggered by the trading of derivative products, but empirical verification of this view is difficult. In this section, developments in the cash market and derivatives markets against the background of falling bond prices since mid-January will be discussed, and several facts helpful in examining the relationship between the cash markets and derivatives markets will be pointed out.

As far as the observed facts are concerned - to state the conclusion at the outset - it may be doubted whether the trading of derivatives played the leading role in causing the fluctuations of underlying bond market prices. Rather, it is more reasonable to take the view that similar fluctuations of cash market prices would have occurred even without derivatives trading.

(i) The cash market and the futures market

Observing the relationship between underlying bonds and futures of JGBs (Chart 3), it is found that while bond prices were falling from the beginning of the year through March, the basis (the theoretical futures price, calculated from the cash price, less the actual futures price) narrowed considerably; this indicates that the selling pressure in the underlying bond market was stronger than in the futures market. When the bond prices fell again after May, little change occurred in the basis, indicating that futures and underlying bonds were sold to almost the same degree.

As far as these observations are concerned, developments in the futures market have not necessarily been the leading cause of bond price fluctuations during the rise in long-term interest rates since the beginning of the year.[2] Although the sales of futures might have triggered a decline in bond prices within a day or two at most, it is more

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[2] The sales of JGB futures by overseas "hedge funds" were suspected to be an important cause of the underlying bond price fluctuations in Japan during the periods of falling bond prices, both in the January-March period and after May. However, interviews with market participants revealed no evidence of any sustained increase in selling orders from hedge funds during these periods, although it is difficult to confirm this claim quantitatively.

appropriate to regard that the upward trend in long-term interest rates was determined by the changes in investors' and dealers' views of economic conditions, that is, expectations of economic recovery.

(ii) The cash market and the yen-yen swap market

Looking at the relationship between the cash market and the yen-yen swap market (Chart 4), it can be found that like the basis, the difference between the swap rate and the government bond yield narrowed considerably or remained stable during the periods of declining bond prices in March and June. Thus no indication can be found that swap trading was the leading cause of the rise in bond interest rates.

(iii) The cash market and the options market

The behaviour of the options market since mid-January has been basically in line with that in the underlying bond market and the price expectations in the cash market (Chart 5). So it is not necessarily true that options trading exerted a major influence on the underlying bond price fluctuations.

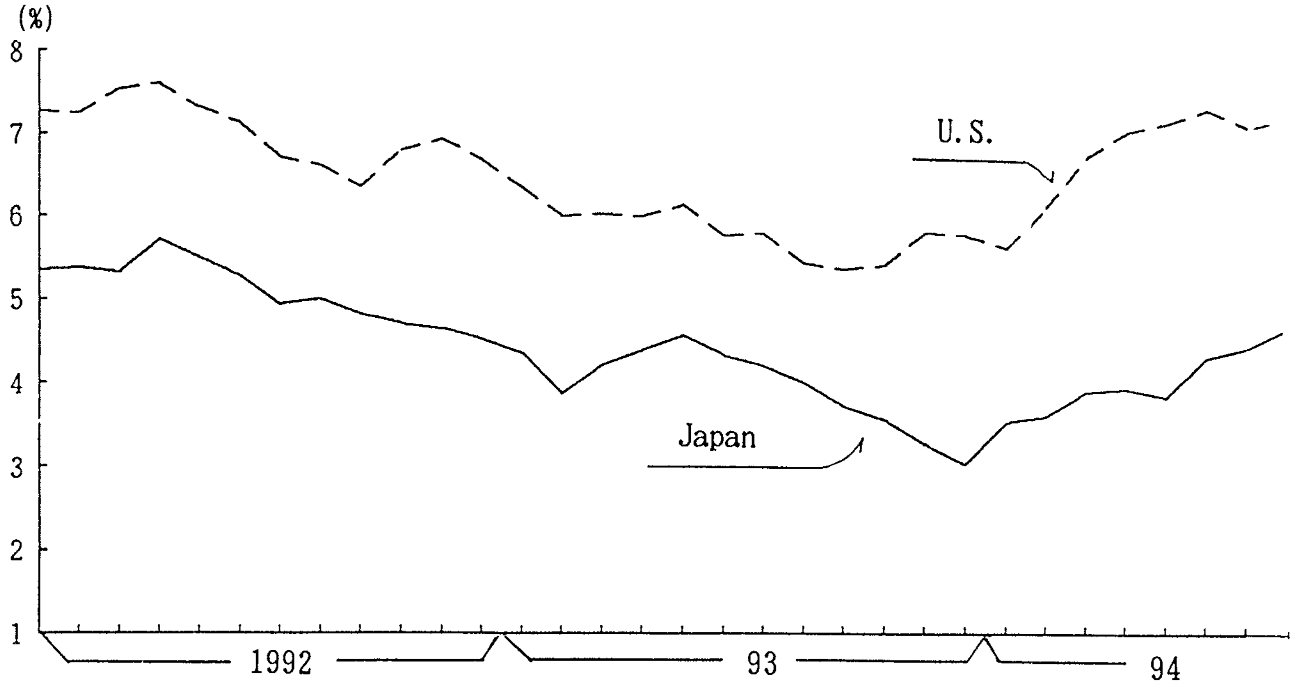
The implied volatility of over-the-counter (OTC) bond options, both call and put, did not rise noticeably until mid-January. This means that market participants must have considered the price decline was temporary in the earliest stage of the rates rise. But as the underlying bond prices fell sharply from mid-January to the beginning of February, the implied volatility rose sharply to a level exceeding 10% annually. From this standpoint, even without the options trading a similar decline in underlying bond prices might well have occurred. Moreover, the trading volume of options was reduced during the same period because the market makers, whose risk control seems insufficient to deal with rapid rise in long-term interest rates, failed to play the significant role in the OTC bond options market. Therefore, there is no actual evidence that options trading did cause the fluctuations of underlying bond prices.

The phenomenon described above was also observed during the period of falling prices after May. In addition, from the end of May to early June when underlying bond prices were falling sharply, futures were sold widely while call options were being increasingly purchased. (The implied volatility of call options exceeded that of put options.) This can be interpreted to mean that the options market provided an insurance against price uncertainty in unstable market conditions (thus the possibility that the options market could be a factor stabilising prices instead of one accelerating their decline). This point becomes even more evident when the ratio of call and put option trading volume in the JGB futures option market is studied (Chart 6; call/put ratio). The trading volume of call options exceeded that of put options during the periods of sharply falling bond prices in March and June. This indicates that despite the selling pressure in the underlying bond and futures markets, a significant demand to purchase call options existed as a hedge against the possible rebound in bond prices.

(CHART 1)

Long-Term Interest Rates

10-Year Government Bond Yields



Changes in Long-term Interest Rates

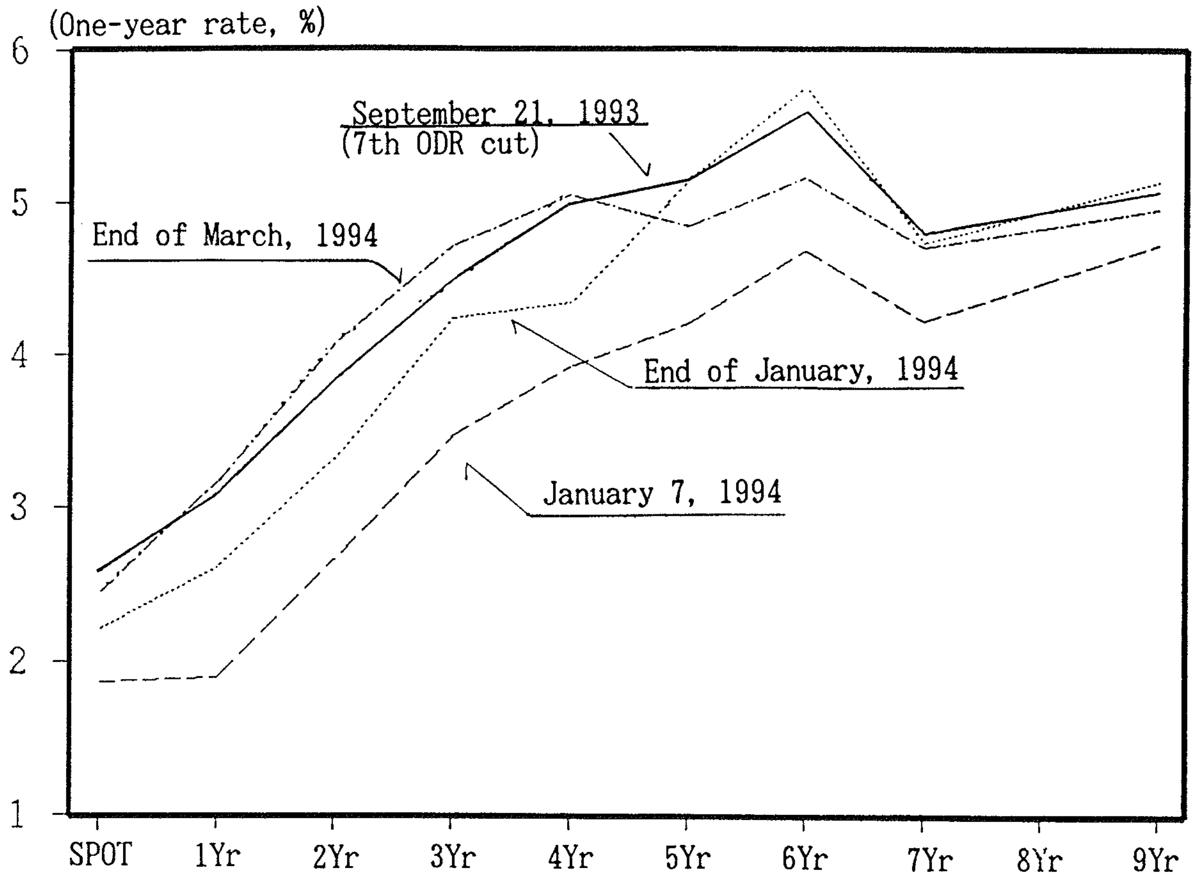
(%)

	Japan (10-year benchmark JGB)	U.S. (10-year bond)
Recent Bottom	2.970 <Jan. 7,10, 1994>	5.16 <Oct. 15, 1993>
Recent Peak	4.775 (+1.805) <July 30,31, 1994>	7.47 (+2.31) <May 9, 1994>
Latest Level	4.560 (+1.590) <Sept.16, 1994>	7.49 (+2.33) <Sept.16, 1994>

* Figures in parentheses are changes from the recent bottom (percentage points).

(CHART2)

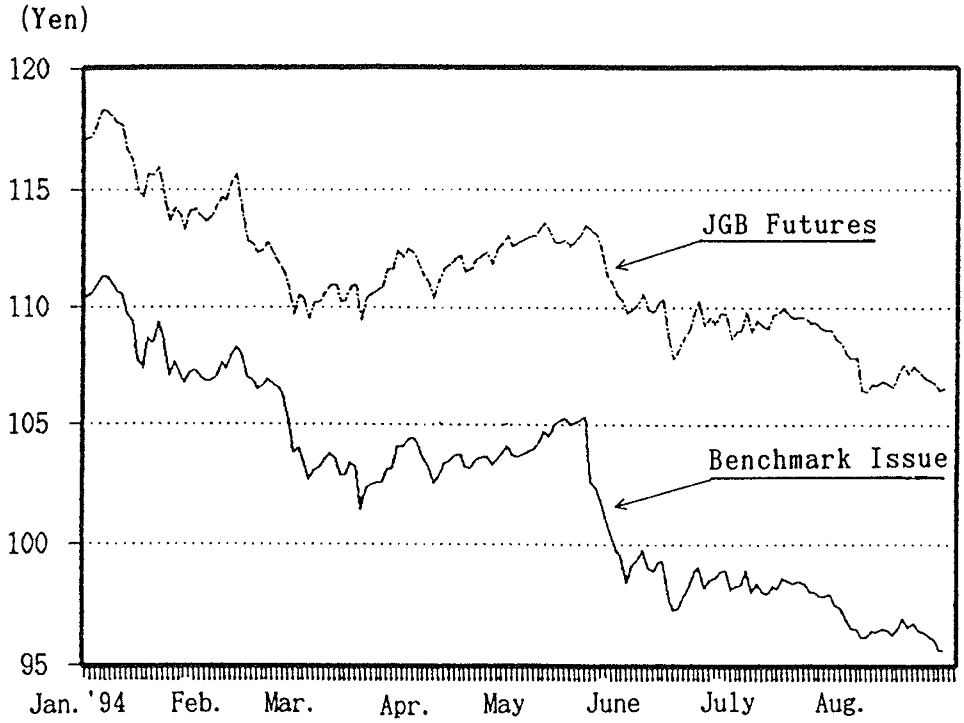
Implied Forward Rates



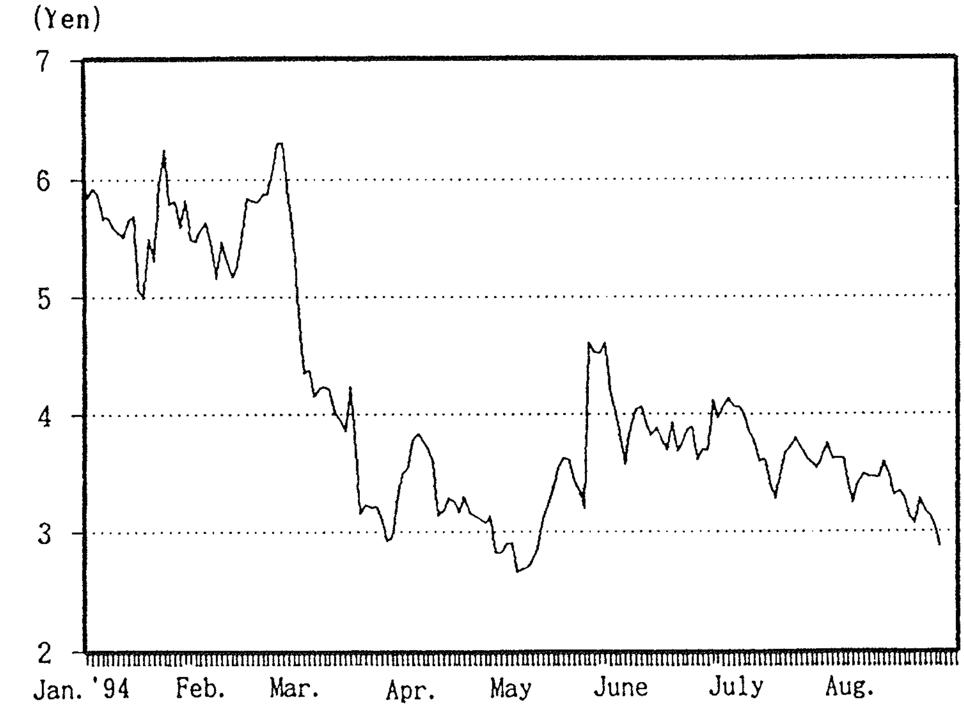
(CHART3)

Prices of a Japanese Government Bond and its Futures

Prices of a JGB Benchmark Issue and JGB Futures



Basis (theoretical future price* - actual future price)

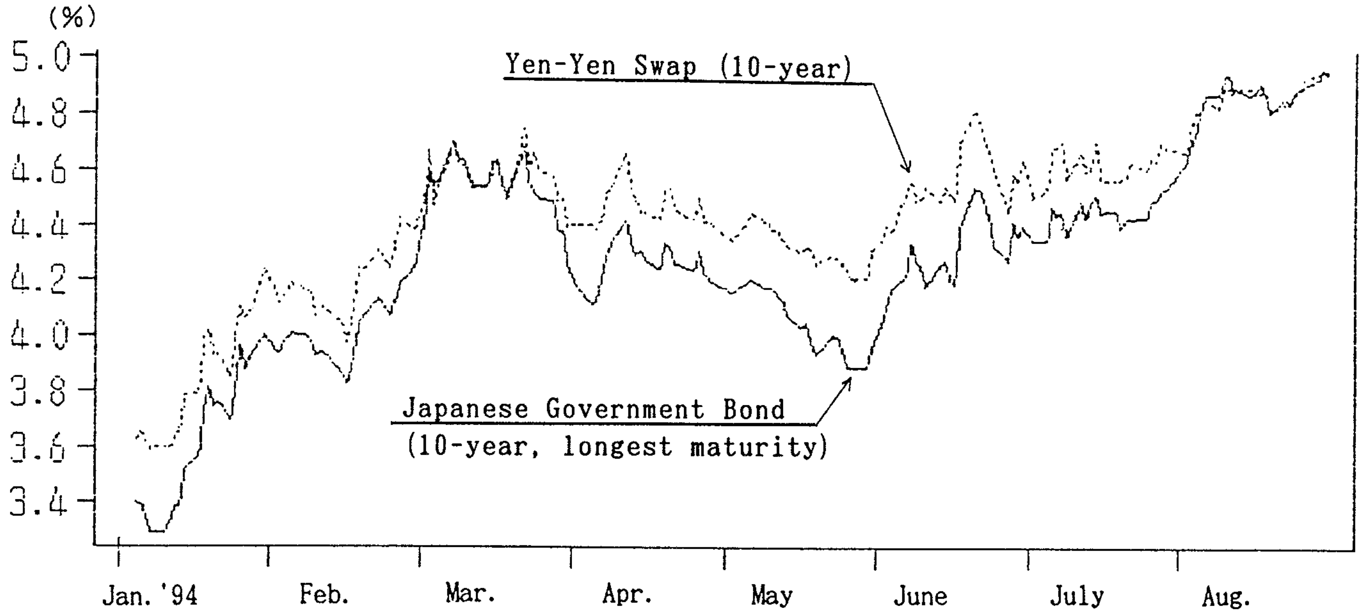


*calculated from cash price

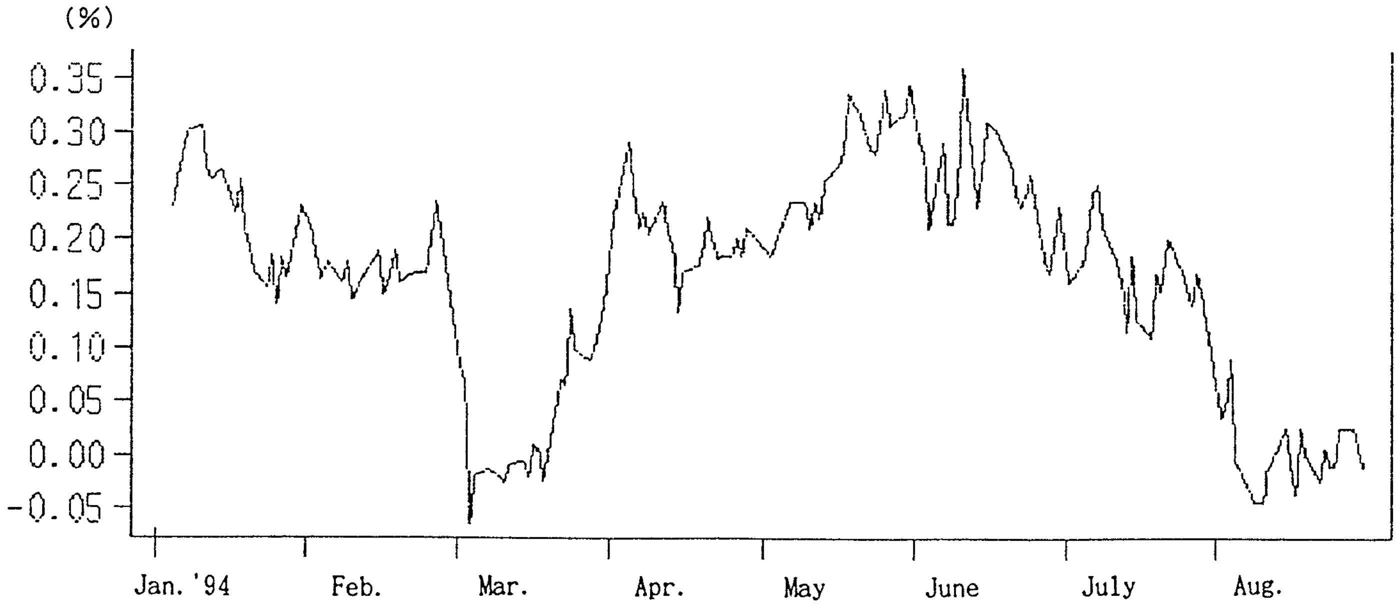
(CHART4)

Yields of a Japanese Government Bond and the Yen-Yen Swap

Yields of a JGB and the Yen-Yen Swap



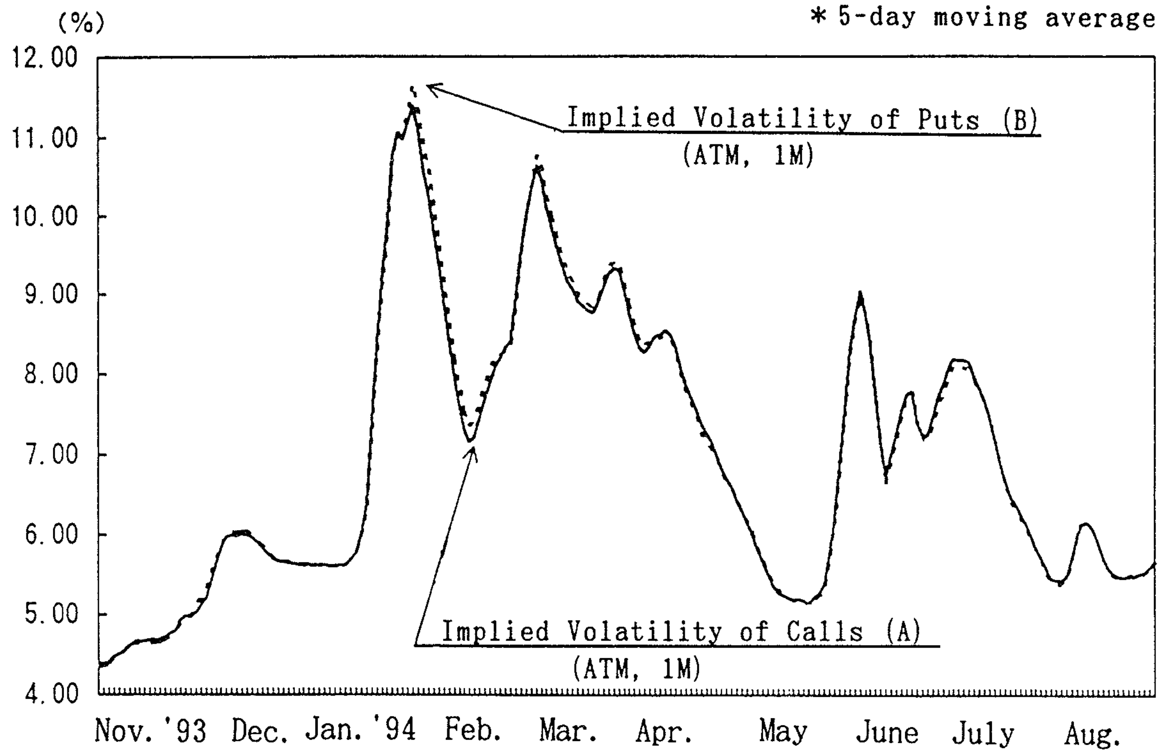
Differential between the Yen-Yen Swap and a JGB

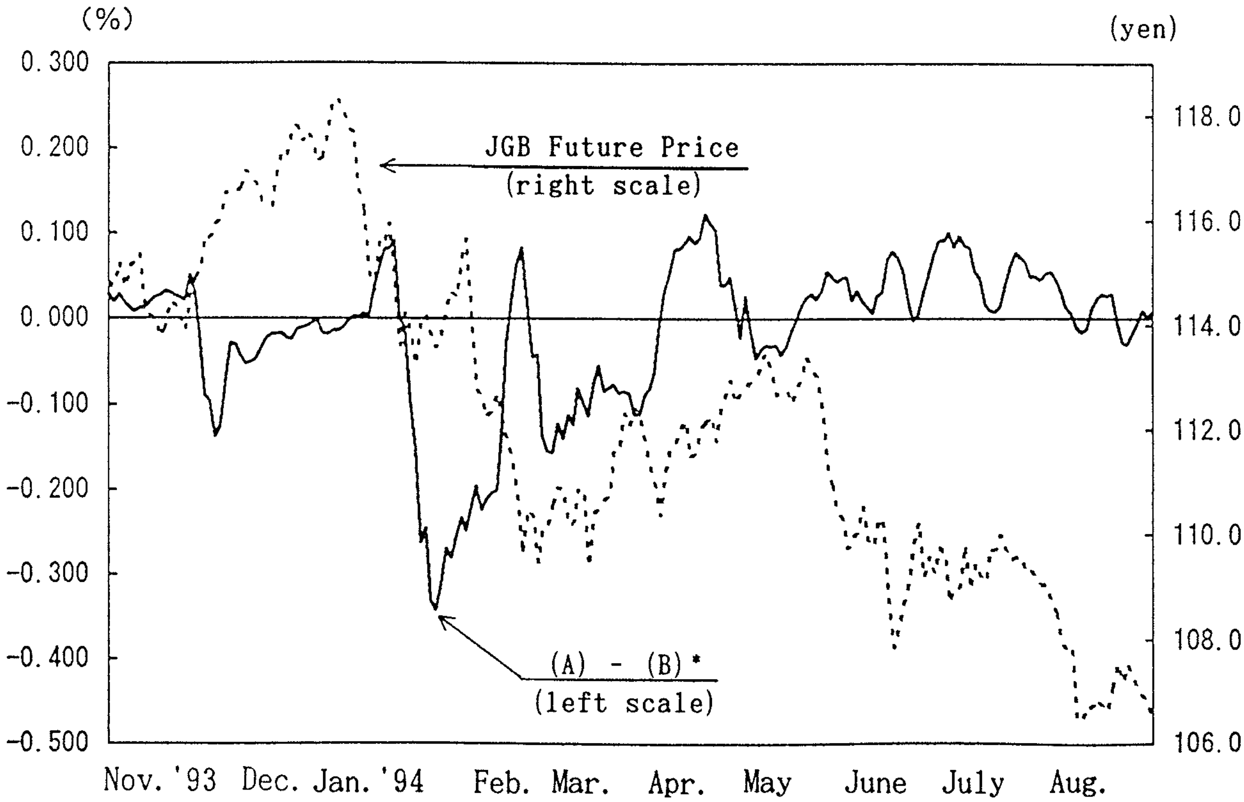


(CHART5)

OTC JGB Options Volatility

Implied Volatility of OTC JGB Options*

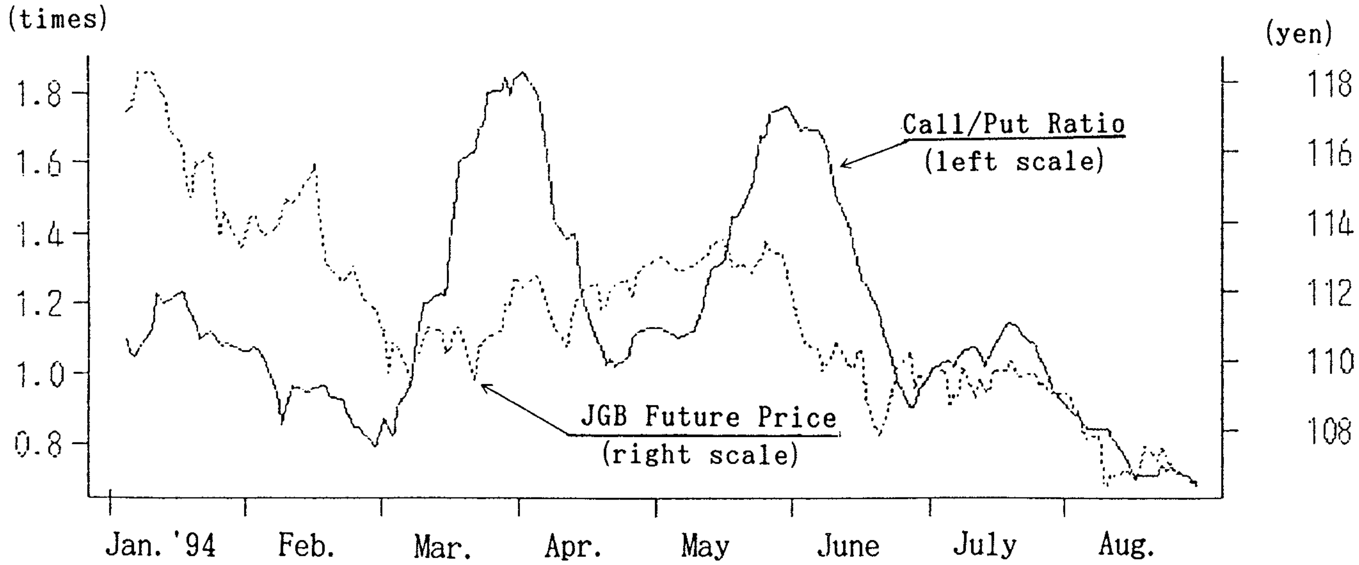




* 5-day moving average

(CHART6)

Call/Put Ratio* of JGB Futures Options



* Turnover of JGB Futures Call Options/Turnover of JGB Futures Put Options

Annex V

Mortgage Security Hedging and the US Yield Curve

Federal Reserve Bank of New York

The large increases in long-term interest rates in response to tighter US monetary policy in early 1994 has been attributed to macroeconomic phenomenon such as expectations of higher inflation and higher future US short rates. This appendix offers an additional explanation: the hedging of mortgage backed securities (MBS) in the US Treasury market may have magnified any increases in long rates which accompanied policy tightening. In particular, reports from market participants, evidence on prices and volumes of mortgage securities and Treasuries, and information from the repo and futures market all suggest that MBS hedging was widespread and had a significant impact on the short-run movements of the Treasury market, particularly for 10-year securities. To the extent that such hedging activity has become a standard feature of the US marketplace in the last few years, it may have permanently altered the short-run dynamics of the US yield curve, and thus changed the transmission of monetary policy.

Although mortgage-backed securities are not in a strict sense derivative financial instruments, many of the issues related to the dynamic hedging of MBSs are relevant for some classes of derivative products. In particular, mortgage securities have an uncertain final maturity because of embedded, path-dependent options which are also present in derivative products such as index amortising rate swaps and some types of structured notes. More generally, like MBSs, many derivatives contain risks which cannot be perfectly hedged; instead hedges require continuous monitoring and adjustment. The adjustment of such imperfect dynamic hedges, particularly during periods of financial market distress, may produce positive feedback on already declining prices. Below we discuss how this mechanism may have worked for the US mortgage and Treasury markets in 1994; however, the issues raised here are likely relevant for derivative markets as well.

Movements in the treasury yield curve

Chart 1 highlights several significant movements in the US yield curve since the fall of 1993. First, long rates began to rise in October of 1993, well before monetary policy tightened. Second, despite little or no observable inflation pressure, the Treasury yield curve did not flatten after policy was tightened: the 10-year yield rose by more than the overnight Fed funds rate. Third, after the policy change in February, the yield curve became more hump-shaped: the 2-year Treasury yield rose by more than the 10-year, and the 10-year by more than the 30-year. In fact, since the mid-1980s, the short-run responsiveness of US long rates to changes in short rates has increased sharply.

It is an interesting coincidence that US yield curve dynamics changed simultaneously with large-scale structural changes in financial markets, in particular the development of new financial instruments and the widespread securitisation of home mortgages in the US.[1] To the extent that mortgage securitisation caused quicker adjustments of mortgage portfolios to changing market conditions and thus brought closer links between mortgage and Treasury markets, it may have contributed to the change in yield curve dynamics.[2]

How MBS hedging using treasuries could steepen the yield curve

When interest rates rise, households prepay their home mortgages more slowly, causing both the duration and the expected maturity of mortgage-backed securities to increase. In effect, MBS owners have sold homeowners an option to prepay their mortgages with little or no penalty. Thus, homeowners can refinance their long-term fixed rate mortgages when rates fall, but can retain those mortgages when rates rise. The latter case is known as extension risk: slower prepayments by homeowners

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1 In 1983, less than 20% of the stock of US residential mortgage debt was securitized; by 1993, nearly 50% was securitised. The mid-1980s change in yield curve dynamics may also have been a delayed reaction to the 1979 change in Fed policy "regime" toward a stronger anti-inflation bias.

2 Mortgage securitisation may have contributed to the greater sensitivity of long-term interest rates to short-term interest rates by moving residential housing finance away from financial intermediaries and directly into financial markets. Before mortgage securitisation, a rise in short-term rates would hurt the cash flows of financial intermediaries who held mortgages, but because mortgages were not marked to market, intermediaries were probably slow in adjusting their asset portfolios to reflect the decline in mortgage values. This slow portfolio adjustment meant that any feedthrough to long-term interest rates was probably indirect and slow. With the advent of mortgage securitisation, however, the majority of mortgages are not held on bank balance sheets but in MBSs, which are marked-to-market daily, and in many cases, are dynamically hedged. Further, portfolios containing mortgages are adjusted more quickly, and as a result, the adjustment of long rates to short rates is probably quicker as well.

increase the duration of an MBS, i.e. increase the sensitivity of MBS prices to rising yields. Because of the imbedded optionality, slower prepayments can cause a sharp decline in the price of a MBS and a large increase in its estimated duration, even for relatively small changes in interest rates.

Table 1 illustrates this with estimates of prepayment rates and duration for a FNMA 7 1/2% coupon MBS pass-through. Although US long rates began rising in late 1993, dealer estimates of MBS prepayment rates and durations did not change sharply until after the change in US monetary policy in February. (Presumably this occurred because the policy change signalled that further declines in interest rates were unlikely.) Duration of this MBS was basically unchanged from October to February at about 3 1/2 years, and then rose sharply after the policy change in February to nearly 5 1/2 years by mid-May.

When rates rise, market participants, particularly mortgage securities dealers and portfolio managers, commonly seek to counteract the increased price risk in MBS and CMOs by taking short positions in similar duration Treasury securities. Thus, the increase in MBS and CMO durations could cause participants to similarly increase their sales of (or short positions in) long duration Treasuries. For example, hedging the MBS in Table 1 would call for a short position in 4-year Treasuries in February, but a short position in 7- to 8-year Treasuries by May. If market participants all attempt to adjust their Treasury positions simultaneously, the increase in "supply" of long maturity Treasuries could cause their yields to rise by more than shorter maturity bonds, and the yield curve could steepen.[3]

Both mortgage pass-throughs and collateralised mortgage obligations (CMOs) are subject to extension risk as prepayments fall. By construction, however, some CMO tranches are substantially more sensitive to such risks (and thus might require larger changes in hedges) than the underlying pass-through. For such securities, Table 1 may underestimate changes in durations and thus required hedges. In addition, by more sharply segmenting risk, the CMO innovation may have increased aggregate hedging using Treasuries, particularly if the CMO tranches with the highest risk are also those most likely to be actively hedged by market participants.

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[3] The higher long-term yields could, in turn, reduce refinancing and prepayment rates even further, again increasing MBS duration (and its price sensitivity) and causing further changes in Treasury hedges. Thus MBS hedging could cause positive feedback or a "multiplier" effect which would further steepen the yield curve. Furthermore, this process is probably symmetric. When interest rates fall, durations and maturities of MBSs shorten and MBSs are subject to call, or refinancing, risk. To hedge such call risk market participants could sell shorter duration Treasuries and buy longer duration bonds, putting more downward pressure on long-term yields in the short run.

In addition, mortgage market developments during March and April were unmistakably influenced by the liquidation of high-risk CMO collateral by a number of investors, most notably Granite Capital, a highly leveraged MBS fund which failed. Because of the customised nature of many tranches, the CMO market is generally less liquid than the market for MBS pass-throughs. The additional pressure of large-scale liquidation virtually eliminated liquidity in some CMO tranches in late March and early April, particularly those with high duration. Thus, many CMO investors were pressured to hedge instead of sell.

Evidence

Some market participants estimated that from October 1993 to April 1994, aggregate dynamic hedging of mortgage extension risk by dealers, portfolios managers and other investors resulted in Treasury market sales of over $300 billion in 10-year Treasury equivalents. While this number is impossible to verify, the circumstantial evidence below suggests that mortgage security hedging using Treasuries had a significant, although probably not dominant, effect on US yield curve movements in late 1993 and early 1994.

Because mortgages are usually hedged with Treasuries up to 10 years in maturity, but not with 30-years, the 40 basis point flattening of the US Treasury curve between 10 and 30 years (Chart 1) provides some evidence consistent with MBS hedging affecting the Treasury yield curve. In contrast, MBS hedging does not explain the "bulge" in the Treasury curve from 2 to 5 years over the same period. Indeed, MBS hedging should have put downward pressure on 2-year Treasury yields in particular. It seems likely that the widely cited macroeconomic factors, such as expectations of higher inflation and higher future interest rates, dominated movements at the short end of the yield curve.

Despite this ambiguous yield curve evidence, daily price correlations between MBSs and both short- and long-term Treasuries are consistent with MBS hedging. The duration changes in Table 1 suggest that from October to May, MBSs should have behaved progressively more like 10-year securities and less like shorter term securities. Chart 2 shows just such a pattern. When US long rates began to rise in late 1993, the correlations between prices of 2-year Treasuries and the 7 1/2% FNMA MBS fell, while the MBS/5-year correlations rose slightly.

After the policy tightening in February, MBS/2-year correlations dropped again; correlations between the MBS and the 5-year Treasury dipped slightly; but the

10-year/MBS correlations were stable or rising. Further, the timing of the changes in price correlations correspond quite closely to the increases in MBS duration in Table 1.

MBS and CMO activity is certainly large enough to affect the Treasury market. Dealer inventories of MBS, both pass-throughs and CMOs, are about the same size as the supply of new 5- to 10-year Treasuries (which are most likely to be used for hedging purposes). Further at year-end 1993, private holdings of Treasury marketable debt maturing in 2-10 years were smaller ($964 billion) than outstanding securitized agency mortgage debt ($1,350 billion).[4]

Perhaps the most direct information on demand for Treasury securities for hedging purposes comes from the market for overnight Treasury collateral: the "Repo" market. The holder of Treasury collateral pays the repo rate to the party seeking to borrow the collateral (often for short selling in the cash market). Repo rates for particular maturities are commonly presented as spreads relative to the rate for general collateral. A high repo spread (i.e. low repo rate) can be interpreted as the financing premium that a short seller must pay in order to borrow a particular maturity Treasury security overnight. In Chart 3, repo spreads from January to April 1994 are consistent with high demand for progressively longer dated Treasuries presumably for hedging mortgage security extension risk. Spreads widen first for 5- and 7-year maturities and then for the 10 year.

Further evidence of increased hedging activity can be seen in Chart 4 which shows open interest in the 5- and 10-year Treasury futures market from the beginning of 1994. These data support the repo data, as open interest increased first for the 5-year contract and then for the 10-year as rates continued to rise.[5] Moreover, the increase in open interest for the 10-year corresponds closely to high and sustained financing premium in the 10-year repo market through April.

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[4] Approximately two-thirds of dealer inventories and slightly more than half of agency mortgage debt are CMOS.

[5] Increases in open interest suggest that market participants have established more permanent positions, and thus they may be interpreted as evidence of increased hedging activity within the futures market.

Summary

The circumstantial evidence presented above, as well as widespread reports from market participants, suggest that shifts in mortgage security hedges and realignments of portfolios in response to longer MBS durations had a significant effect on the Treasury yield curve, particularly after the change in US monetary policy in February 1994. Although MBS hedging certainly cannot explain all the shifts in the US yield curve in early 1994, there is some macroeconomic evidence which support it: the flattening of the 10- to 30-year spread in early 1994 and the increased (short-run) sensitivity of long rates to changes in short rates. In addition, estimates of mortgage prepayments and durations, evidence on MBS/Treasury prices and volumes, and information from the repo and futures market all suggest that the hedging of mortgage securities was widespread and had a significant impact on the short-run movements of the Treasury market, particularly the 10-year market.

Although there is no evidence that hedging activity has affected the long-run relationship between long-term and short-term interest rates, this latest episode is further evidence that the short-run dynamics of the US yield curve have changed over the last decade. As a result, the transmission of monetary policy from short-term interest rates to the real economy, via long-term interest rates, has probably changed as well.

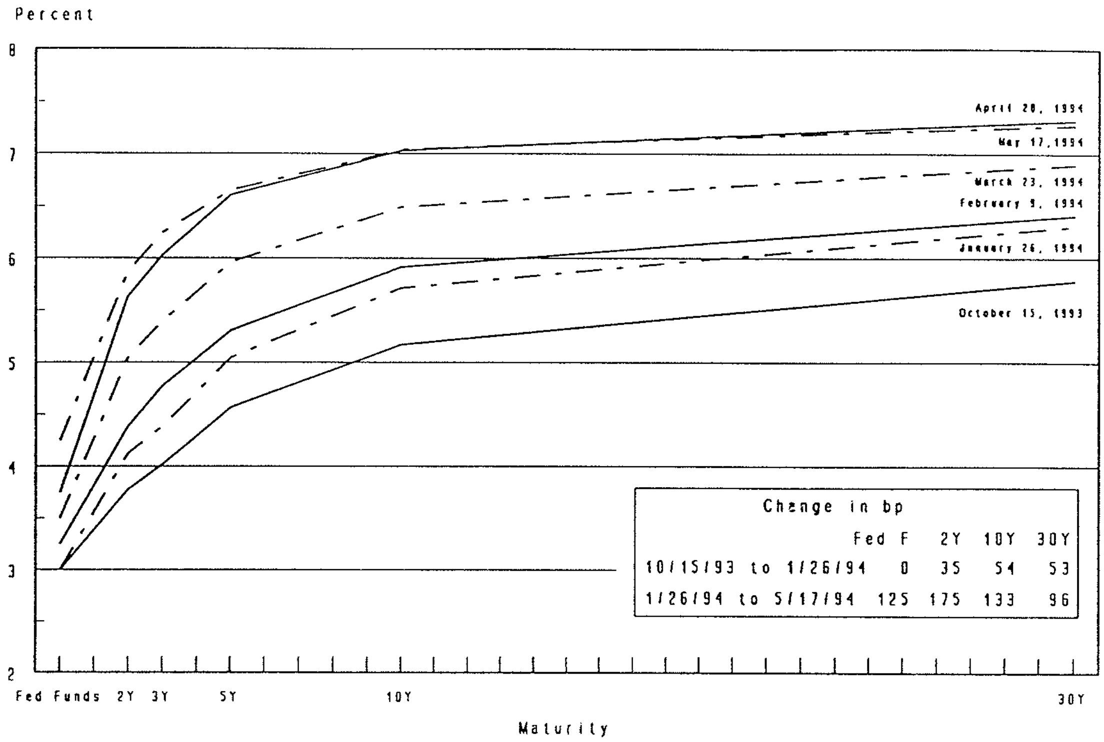
Table 1
Dealer Prepayment Forecasts and Effective Durations
FNMA 7.5% coupon 30-year conventional MBS

Date	"Effective" Duration (years)	Prepayment forecast (CPR, %)	10-year yield (%)	Fed funds rate (%)
15th October 1993	3.40	21.8	5.17	3.00
26th January 1994	3.49	20.8	5.71	3.00
9th February 1994	3.52	20.8	5.91	3.25
23rd March 1994	4.81	11.9	6.49	3.50
20th April 1994	5.27	9.5	7.03	3.75
17th May 1994	5.41	9.0	7.04	4.25

Source: Bloomberg L.P. Prepayment forecasts are dealer medians quoted in PSA and converted to conditional prepayment rates (CPR). Effective durations were calculated with dealer median prepayment forecasts using Bloomberg analytics. Dealers include: First Boston Corp., DLJ, UBS Securities, Paine Webber, Bear Stearns, Smith Barney, Prudential Securities, Merrill Lynch, Lehman Bros. and Salomon Bros.

CHART 1

Treasury Yield Curves

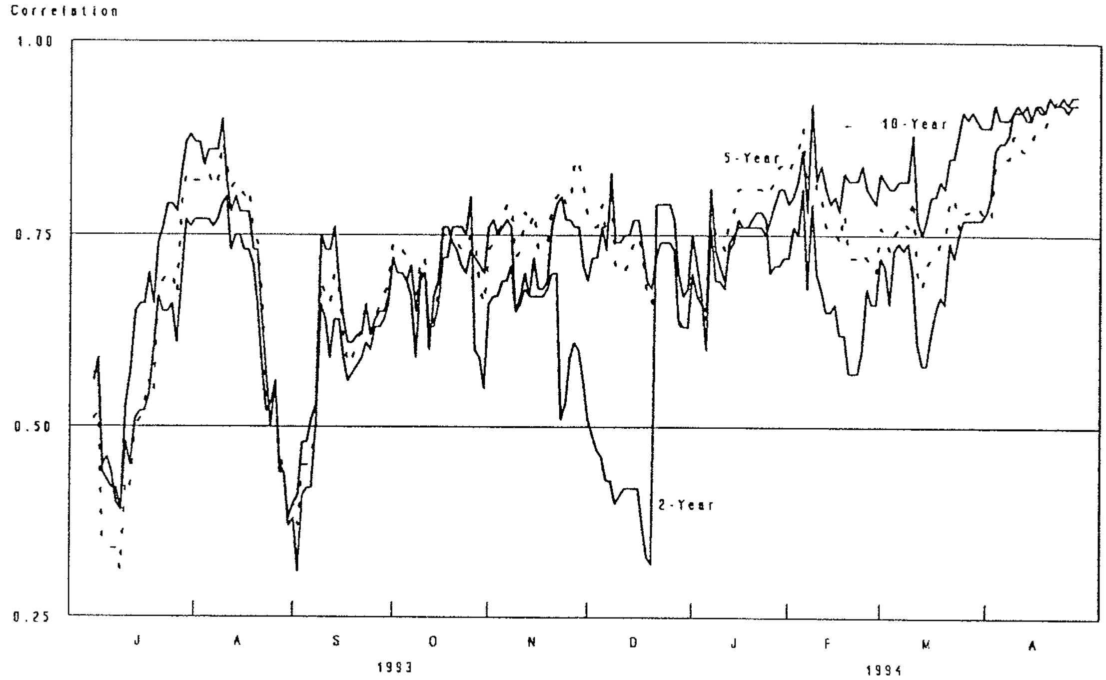


Source: Bloomberg L.P.

CHART 2

Price Correlations: MBS and Selected Treasuries

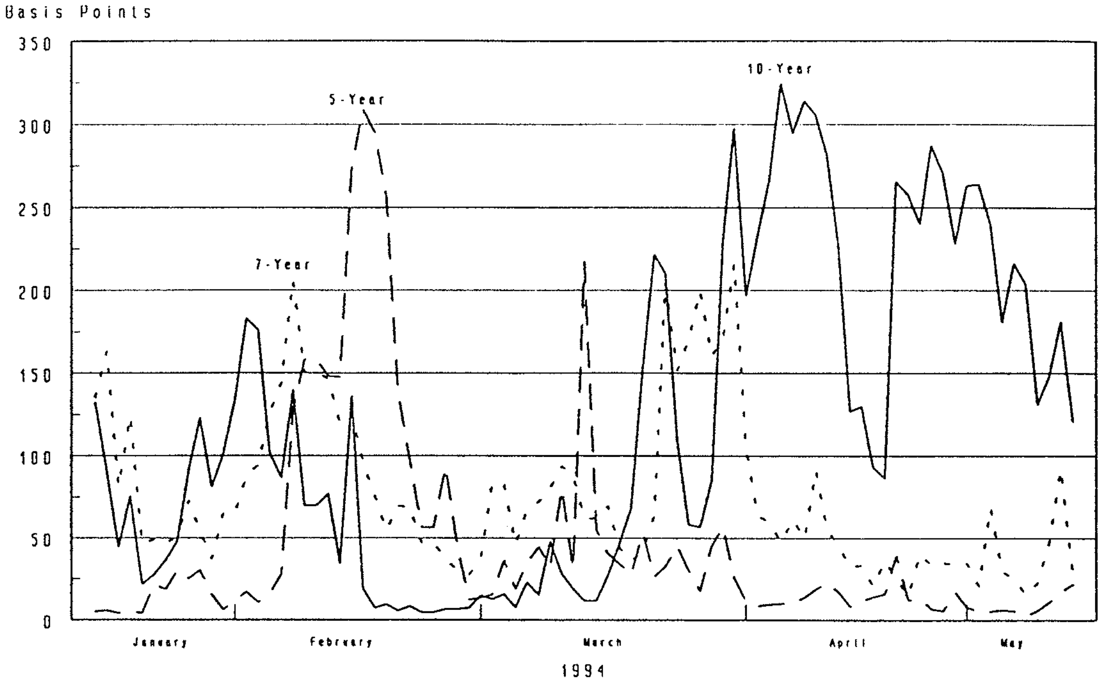
FNMA 7.5% Coupon with 2, 5 & 10-Year CMT



Twenty day rolling correlation.
Source: ORI.

CHART 3

Selected Treasury "Repo" Spreads

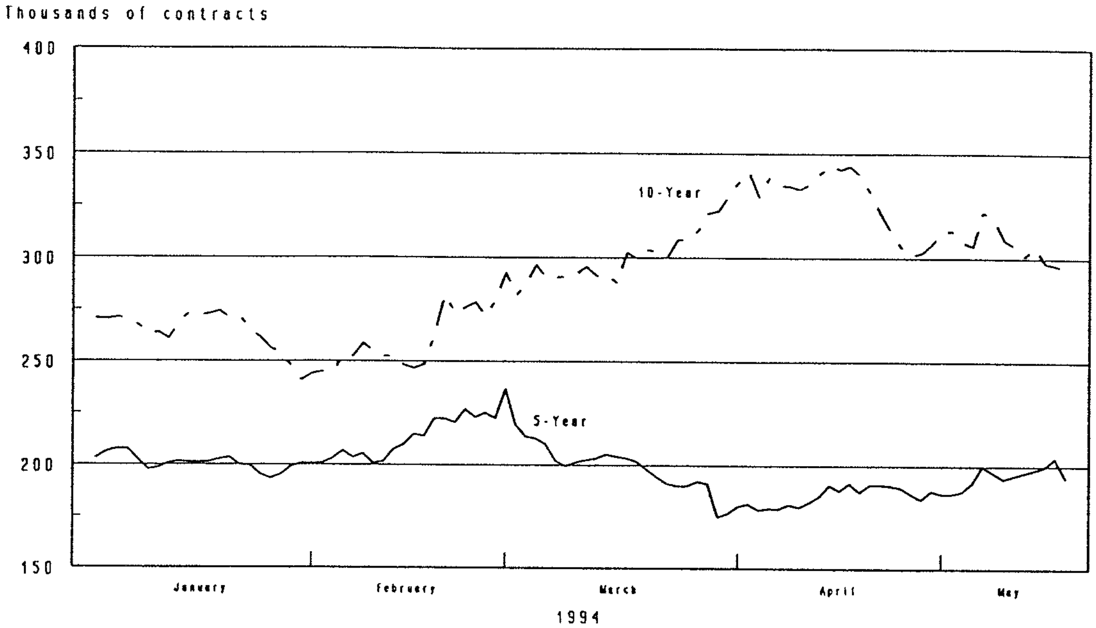


General repo rate minus repo rate on specific maturity.
Daily data, 1/03/94 to 5/13/94.
Source: Federal Reserve Bank of New York.

CHART 4

US Treasury 5 and 10 Year Note Futures

Open Interest



Daily data, 1/3/94 to 5/18/94.
$100,000 face value.
Source: CBOT, DRI.

Annex VI

Some guidelines for gauging market sentiment from derivatives markets data

Banque de France

As mentioned in the main text of the report, market data on derivatives instruments provide quantitative indicators about expected values of a wide range of asset prices. These indicators combined with other quantitative information derived from the cash market and more qualitative information gathered through ongoing discussions with major market actors can help central banks to draw a synthetic picture of market participants' expectations regarding interest and exchange rates at various time horizons. We describe below how this picture can be created from three main building blocks: the expected value of interest and currency rates, the dispersion of expectations, and the shape of the distribution of expected price changes.

I. Expected values of interest and currency rates

Depending on their nature, the price of some derivatives instruments - on interest and currency rates - expresses either directly or indirectly the expected value of the underlying asset. To illustrate this point, we turn successively to short-term rates, long-term rates and currency rates.

1. Short-term interest rates

The most straightforward way of assessing expected short-term interest rates is to look at the price of futures contracts on 3-month euro or domestic deposits. The availability and liquidity of these contracts in the main currencies, for maturity dates up to at least one year can be used to extract the expected price paths for interest rates at different time horizons and make comparisons for the G-10 countries. Futures on 3-month deposits are equivalent to standardised FRAs and their value therefore corresponds to the expected 3-month forward rate at the expiration of the contract implied in the cash yield curve.[1] One can also use FRAs rates since in a well-functioning market, the price of a future short-term interest rate contract cannot deviate significantly from the equivalent FRA rate.

2. Long-term interest rates

A zero coupon bond or swap yield curve is usually used to assess expectations about long-term interest rates (i.e., 2, 5 or 10 years) and make comparisons across countries. The methodology consists of extracting, for instance, the implied 5 years zero coupon rate in one year built into a 6 years zero coupon cash rate. The reasoning behind this methodology is the same as for short-term interest rates (see footnote 1).

Derivatives, notably FRAs, can also provide the same type of information. It should be pointed out, however, that the market for this type of product is not so broad and liquid as for FRAs on short-term interest rates or futures on 3-month euro or domestic deposits. Therefore, it is not certain that derivatives will provide a more accurate view of market expectations than forward-forward rates derived from cash yield curves. More generally, it can be pointed out that futures on notional government bonds, which benefit from large markets on most of the G-10 Government treasuries, do not provide good estimates of expected long-term rates for longer time spans since liquidity is usually concentrated on the contract with the nearest settlement date, usually

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[1] The price of a future contract is linked to an arbitrage relationship which is based on the following reasoning: assume that on 9th September 1994 an investor wished to invest in a French domestic deposit for 191 days, up to 19th March.

To this end, he can implement two strategies:

- invest in a 191 days (t_1) deposit;
- invest in a deposit for 101 days (t_2) and simultaneously buy a Pibor futures contract, maturing on 19th December.

With both strategies the investor locks in an investment rate for 191 days. In an efficient market, these two strategies, which are perfect substitutes, should yield the same return. The theoretical price of the Pibor contract can therefore be computed in the following way :

$$\underset{1^{st}\ strategy}{\underbrace{(1+R_1\times\tfrac{t_1}{360})}}=\underset{2^{nd}\ strategy}{\underbrace{(1+R_2\times\tfrac{t_2}{360})\times(1+R_3\times\tfrac{t_3}{360})}}$$

Solving this equation for R_3 gives the theoretically implied rate of the Pibor contract. It is equivalent to the forward-forward 3 months deposit rate starting on 19th December which could be extracted from the cash yield curve.

less than 3 months ahead of the trading date. In addition, and above all, the price of a futures contract of that kind depends heavily on:

- the cost of carrying the underlying bond;
- any cash flows, i.e., interest payments, that one would receive if the security rather than the futures contract were held;
- the value of options[2] embedded in the futures contract.

3. Currency rates

Markets expectation for the future spot exchange rate can be obtained by comparing domestic interest rates in the two countries. The conceptual basis for using interest rate differentials derives from the concept of arbitrage between various foreign exchange and money markets. It can be shown that the returns obtainable in any particular currency sold in the forward markets against a base currency should normally be equal to those attainable in the base currency. If this condition does not hold, opportunities for risk-free profit exist, the exploitation of which forces forward rates on currencies to reflect the interest rate differential between the respective currencies.

A quicker way of assessing market's expectations for the future spot exchange rate is to look at OTC currency forwards. On this market future spot exchange rates are directly quoted in the form of forward points. This derivative product provides valuable information for short-term expected currency rates to the extent that its market is large and liquid and that market participants exploit arbitrage opportunities for risk-free profits. However, experience shows that these data do not have good predictive power.

II. Dispersion of expectations

Options markets provide various kinds of information which can be exploited by central banks to assess the dispersion of market participants' expectations about the future evolution of asset prices.

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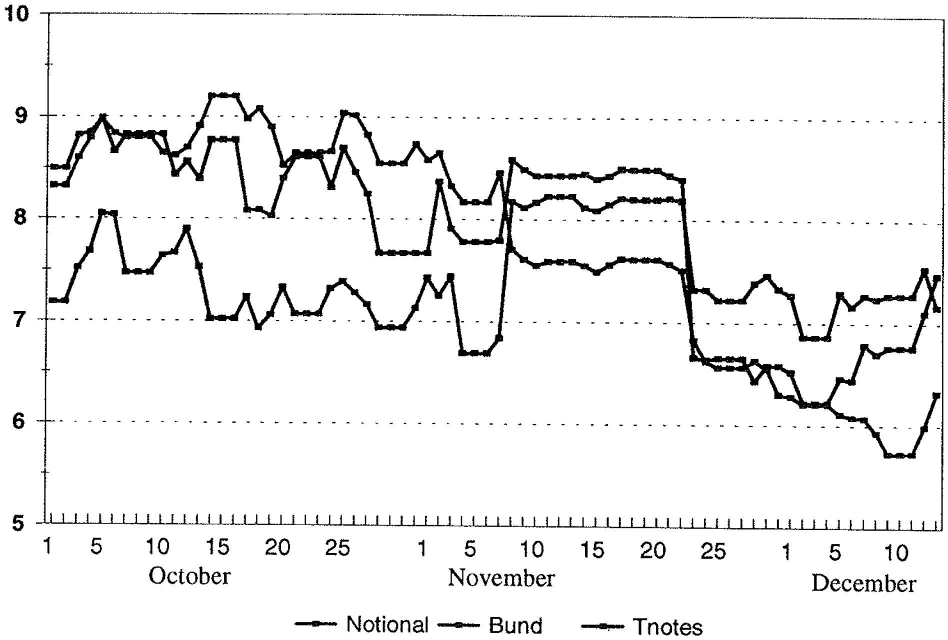
[2] Because the seller of a futures contract determines which issue is delivered and on which day delivery occurs, he has significant advantages over the contract holder. These advantages can be treated explicitly as embedded options and can be valued using option valuation techniques.

The most common indicator drawn from option prices is the **implied volatility** which measures the standard deviation of expected price changes in the underlying assets. This implied volatility can be seen as a synthetic indicator of the level of market participants' uncertainties about the future price of the underlying asset. It can be usefully monitored by central banks on a historical basis and used to make international comparisons. A possible way of presenting this information is suggested below.

Implied volatilities can also be used to estimate probabilities associated with a specific range of expected values of the underlying asset. For instance, on 31st August 1994, the implied volatility of options on the Matif Notionnel, expiring on 24th November, amounted to about 10 %, while the spot price of the underlying asset equalled 112.46. This information can be interpreted as follows: the likelihood of a price of the Matif Notionnel being between 106.84 and 118.08 by the end of November is expected to be 66 %. Theoretically, the above pieces of information can be drawn from any kind of options markets.

IMPLIED VOLATILITY OF AT THE MONEY
most active contract
(march 1995)
from 1 october to 13 december 1994



It should be noted, however, that market practitioners use a variety of models to price options in line with their expectations of future volatility. To back out their views on volatility, one ought ideally to use the same pricing models as them and take an average over all expectations. This problem can be overcome for exchange traded options where few well-known models are used (for options on French futures contracts, for instance, two main models are used: Black Scholes and Cox-Ross-Rubinstein). For OTC options, assessing implied volatilities might be more difficult.

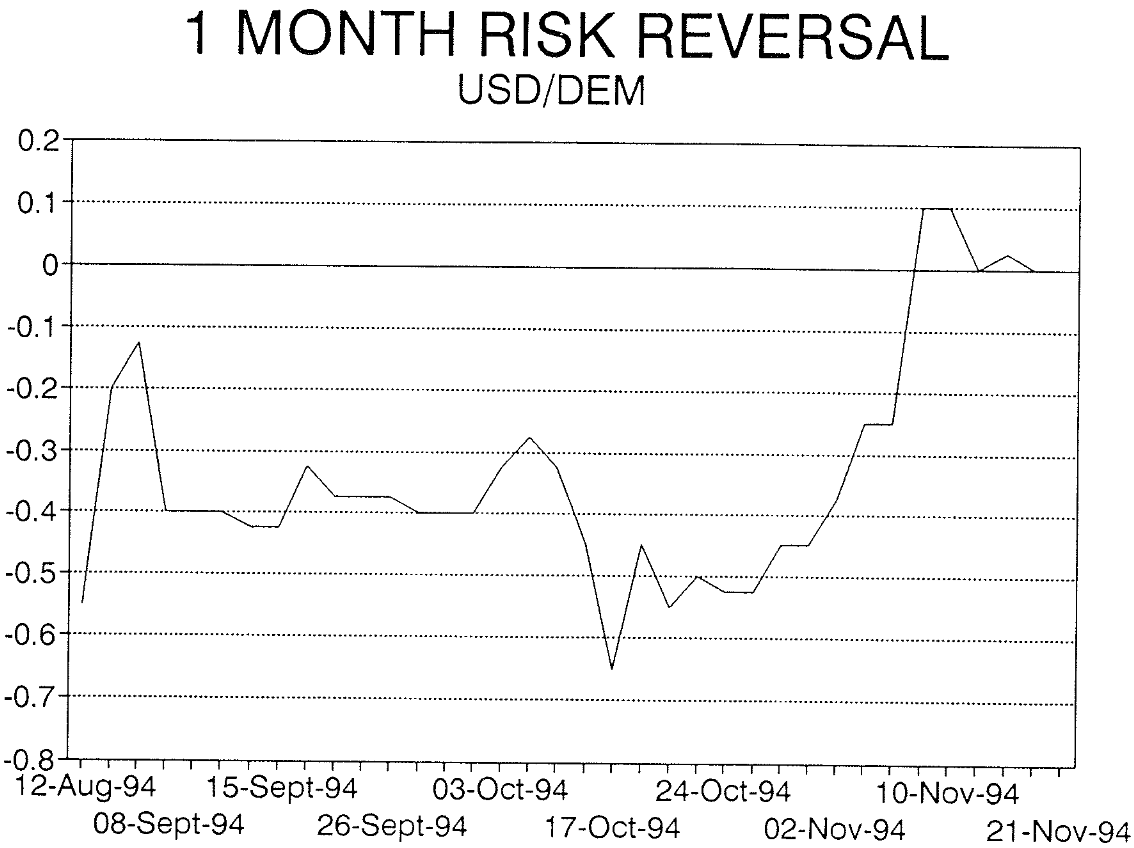
III. Shape of the distribution of expected price changes

Implied volatility is only a summary measure of uncertainty about the price of the underlying instrument. Current market prices on a variety of options contracts can be used to get a more detailed reading of the distribution of market uncertainty. Several tools are available to this end.

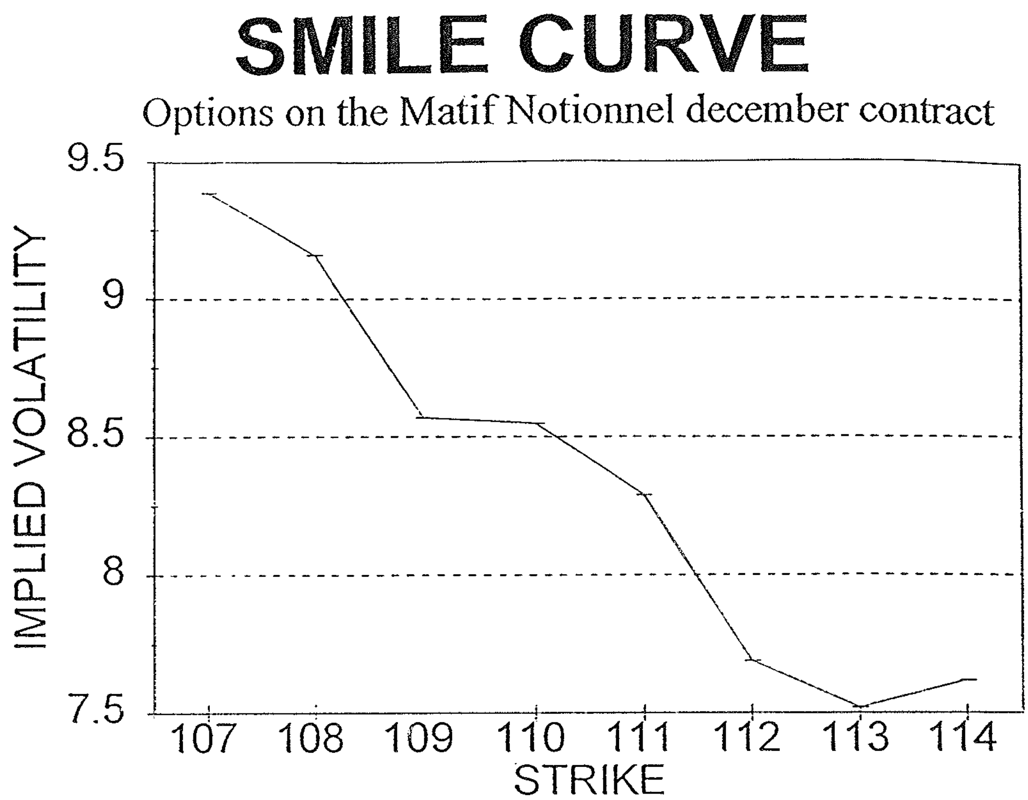
One consists of estimating distributions of expected price changes of underlying assets from options prices. Typically, the estimation of the distribution is based on a model relating the options price to the expected value of the underlying asset, conditional on the option being in-the-money, and takes into account early exercise premiums for American options. The result of this computation can be, for instance, a set of graphs which show the expected distribution of the price of the underlying asset and its evolution. It allows a better understanding of the diversity of market participants' expectations about the most likely scenarios of future interest rate and currency rate movements.

Another tool consists in comparing the prices of calls and puts whose strike prices are spaced symmetrically around the current spot price. If the distribution of expected prices of the underlying asset is symmetric, out-of-the-money European calls and puts should have the same price. Skewed distributions should consequently translate in price differences between calls and puts which may in turn be seen as an indication of market sentiment.

This methodology can be applied to a large variety of options. For currency options, this leads usually to the computation of a "**risk reversal**", which is the difference between the premiums of call and put whose strike prices are spaced symmetrically around the current spot price. In practice, this computation is usually done for options with a delta of 0.25 (options are out-of-the-money when the delta is inferior to 0.5). When the risk reversal is positive, market participants are willing to pay more for the right to buy a currency at a predetermined maximum price than for the right to sell a currency at the symmetric minimum price. This tends to show that they expect an appreciation of the currency. Conversely, when the risk reversal is negative they rather expect a depreciation of the currency.



The same line of reasoning can be applied to options on other underlying assets, like bonds, futures and stocks as long as they are of the European type. It seems more difficult to use the same reasoning for American options because the feasibility of early exercise obscures the influence of the distribution skewness upon relative prices of out-of-the-money calls and puts. However, in the special case of American options on futures contracts, relative prices of out-of-the-money calls and puts can be used according to the above methodology. They lead usually to the construction of a **"smile" curve**. An example of such a curve is provided for options on the Matif Notionnel December 1994 contract on 27th September 1994. The spot price of the December future contract is 110.66. The graph below illustrates the relationship between the volatility (and therefore the price) of out-of-the-money puts (left side of the graph) and the volatility of out-of-the-money calls (right side of the graph). It provides information about the perceived asymmetry of risks in the Matif Notionnel market at that time: the fact that the implicit volatility of puts was higher than that of calls tends to show that investors believed downward movements in the Notionnel market were more likely than upward movements. At the time of the elaboration of this graph, a similar conclusion could be reached for other futures markets like the Bund for instance. While this relationship between the implicit volatility of out-of-the-money puts and calls may not be a good predictor of future prices of underlying assets, it provides useful information about investors' expectations.



Annex VII

Possible use of derivatives for the management of foreign exchange reserves

De Nederlandsche Bank

Foreign exchange reserves are an instrument of exchange rate policy, and in some circumstances also of money market policy. The fact that these reserves should be available at short notice for interventions determines to a large extent the investment possibilities. The currency composition of the reserves and the types of assets suitable for investment, and consequently the types of risks that central banks are confronted with, are largely a function of the monetary role of the reserves.

Central banks use financial markets to implement their policies and to manage the foreign exchange reserves and the risks associated with it. Since one of the main functions of derivatives is to facilitate risk management, in principle they could also be used as such by central banks.

Management of foreign exchange reserves by central banks basically means the management of three types of risk:

credit risk	- potential losses due to counterparty failure;
liquidity risk	- risk that the funds are not or only at a high cost available at the time that they are needed;
price risk	- risk of changes in the value of the reserves due to changes in market prices.

The use of derivatives to manage credit risk directly is not really possible at present. There are no well-established markets which can be used to hedge credit risk. However, derivatives can be used in certain circumstances to reduce credit risk exposure, by providing an investment alternative with very limited credit risk. For an example see below.

The liquidity of the reserves is crucial to central banks, since they may be forced to liquidate investments at very short notice in order to be able to intervene on the foreign exchange markets. Central banks traditionally manage this risk by investing mainly in liquid assets (mainly government paper) and/or by investing in assets with short maturities. Instruments which involve traditional derivatives (like forward bond and forward foreign exchange transactions) can help to manage liquidity by maturity. For instance reverse repo's or so-called buy/sell backs, using bonds as collateral, can provide means of making short-term investments. Foreign exchange swaps can be used to transform part of the reserves temporarily in a different currency, where there may be a better developed money market to invest the reserves in. This is done without affecting net demand or net supply on the currency markets. If the reserves are needed for interventions they can easily be swapped back to the currency best suited for intervention purposes.

More recently developed derivatives like bond futures can be used to create synthetic short-term investments, by selling the future and buying a deliverable bond. When the future matures, the bond will be delivered and the invested sum plus some return is available again. The synthetic instrument can be traded, so it is more liquid than a bank deposit. Furthermore, it does not involve significant risk (there is only a risk on the exchange). This implies that, although derivatives do not provide a hedge against credit risk, they can be used to avoid it in certain circumstances, without sacrificing liquidity.

The conclusion is that derivatives can be useful for central banks in their management of the liquidity of their foreign exchange reserves. This is especially so for those currencies where there is not a well-developed money market.

Since foreign exchange reserves tend to be held in fixed income assets, two different price risks can be distinguished, which are important for the value of the foreign exchange reserves: movements in exchange rates and in interest rates. Most central banks limit the extent to which they actively manage foreign exchange exposure, since this could interfere with other central banks' exchange rate policies. Selling an already weakening currency does not seem appropriate if the central bank involved pursues a strong currency policy. So, although derivatives could in principle be useful for the management of foreign exchange risks by central banks, the potential in practice for these instruments to be used for portfolio management appears limited. Since many central banks do manage their interest rate exposures, there is more scope for derivatives to be used for this purpose.