BANK FOR INTERNATIONAL SETTLEMENTS

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

Report prepared by a working group established by the
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Executive Summary

Since the mid-1970s, the pace and nature of financial innovation have changed dramatically. Higher volatility of interest rates, experience with floating exchange rates, growing levels of indebtedness, and financial deregulation - especially the liberalisation of capital movements - all created a demand for financial innovation. Rapid advances in computer and communication technologies, along with developments in finance theory and increased trading in existing assets, made it possible to meet that demand. Although highly prominent, derivatives - including futures, swaps and options - are only one example of innovations that have altered financial market behaviour in recent years. In this light, derivatives can be seen more as a consequence than a cause of increased volatility in exchange rates and interest rates.

Derivatives fulfil specific economic functions that can influence the way individual economic agents and financial markets respond to monetary policy actions. However, there has been thus far no comprehensive study of their macroeconomic and monetary policy implications. This report makes an effort in that direction. It is part of a broader undertaking by the Euro-currency Standing Committee of G-10 central banks to assess the implications of derivatives markets for central banks' monetary and macroprudential policy responsibilities, to increase transparency in derivatives markets, and to develop measures of their size and of the risks that are transferred in them.[1]

The report has five chapters. The implications of the growing use of derivatives for the environment in which monetary policy is conducted are discussed in chapter one. Chapters two through four discuss, in turn, the possible impact of derivatives on the monetary transmission mechanism, on monetary policy indicators and on the operational instruments of central banks. Conclusions are offered in chapter five. A separately published compendium contains a number of annexes that elaborate on topics dealt with in the main body of the report.[2] These annexes have been prepared by individual central banks who retain responsibility for their contents.

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1 See *A Discussion Paper on Public Disclosure of Market and Credit Risks by Financial Intermediaries*, (the "Fisher" Report), ECSC/BIS, 1994; and *The Measurement of Market Size and Macroprudential Risks in Derivatives Markets* (the "Brockmeijer" Report) ECSC/BIS, forthcoming.

2 See *Annexes prepared by individual central banks for the report on macroeconomic and monetary policy issues raised by the growth of derivatives markets,* ECSC/BIS, 1994.

I. Implications of derivatives for the environment in which monetary policy operates

The expanded use of derivatives has implications for the longer-term efficiency of financial markets and possibly for short-run price dynamics in both derivative and underlying spot markets. These latter implications may differ under normal conditions and during periods of stress.

Derivatives may affect the longer-run efficiency of financial markets in four ways:

- they are, above all, a highly efficient means of adjusting risk exposures for hedging or speculative purposes, and they allow the separation or the "unbundling" of the various kinds of price risks embodied in underlying assets. This facilitates the transfer of risks to those presumably more capable of bearing and managing them;

- they allow the creation of pay-off characteristics at a lower cost than could be generated by a combination of underlying assets, thus greatly expanding the possibilities for trading, hedging and investing in financial markets. Derivatives thus enhance the liquidity of financial markets generally;

- they improve pricing efficiency because they may reveal prices for risks that were not previously priced separately, and because they facilitate the price discovery process.[3] Because it is generally cheaper to transact in derivatives than in the cash market, derivatives tend to lower the cost of incorporating new information into prices;

- they facilitate investment and arbitrage strategies that straddle various market segments, and consequently may increase asset substitutability at both the domestic and international levels.

In the light of these considerations, derivatives are likely to improve the efficiency of financial markets. By allowing more risk to be hedged, they may also afford some borrowers greater access to funding sources, which could reduce the sensitivity of agents' spending to short-term financial constraints. They might be expected in turn to have some, albeit small, favourable effects on the level and stability of investment and on economic growth in the medium and long term.

By improving the efficiency of financial markets, derivatives are likely to make asset prices respond more quickly to changes in the factors affecting supply and

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[3] Price discovery refers to the process by which relevant information is incorporated in prices.

demand, including economic fundamentals. Derivatives should also, under normal conditions, tend to make financial markets more resilient to shocks, as they increase overall market liquidity and redistribute risks towards agents that can be presumed to be more capable of bearing them. In addition, by strengthening linkages among markets, derivatives may help to disperse and dampen shocks affecting any one market segment. **Under normal conditions**, therefore, derivatives markets seem likely to have a stabilising influence on underlying markets.

During periods of stress, however, derivatives may exacerbate short-run price volatility in financial markets. For example:

- the dynamic hedging (i.e. continuous revision of hedge positions) of short options exposures requires purchases of underlying assets in rising markets and sales when prices fall. This can cause an initial price shock to be accentuated through positive feed-back effects;

- "hedging overhangs" could occur in which hedging transactions that are highly effective for an individual firm in normal two-way markets may trigger large price movements when undertaken by many market participants simultaneously;

- margin and collateral calls on derivatives positions in times of heightened volatility may force both derivatives and underlying positions to be liquidated;

- the pricing and trading of derivatives are based on assumptions that price changes obey well-defined statistical distributions, that historical price behaviour is a reliable guide to future volatility, and that underlying markets permit continuous trading. Such assumptions can become invalid in times of stress, generating valuation uncertainties, widening bid-ask spreads in derivatives markets, and in extreme circumstances eroding liquidity.

During periods of turbulence, these mechanisms could reinforce each other. Given the linkages among markets both domestically and internationally, a price disruption in one market could then rapidly affect others.

It should be emphasised, however, that there is little evidence to suggest that the trading of derivatives per se **causes** market turbulence. Market turbulence often follows periods during which some asset prices progressively move out of line with fundamentals, and manifests itself when some event triggers an abrupt correction. While derivatives do not seem to play any causal part in the build-up of asset price distortions, they could, in times of stress, **amplify** market price movements.

As to the implications for the conduct of monetary policy, derivatives do not interfere with the pursuit of price stability. However, at times of stress, consideration of asset market conditions may influence the **tactics** of monetary policy, such as the

timing of policy action. The most effective contribution that central banks can make to avoid times of stress in the first place is to follow a **strategy** that is predictable and well-explained to the public, and to implement that strategy in a consistent manner so as to aid the formation of stable non-inflationary expectations. The latter may call for pre-emptive and/or gradual actions as appropriate. However, these tactics should not compromise the objective of price stability.

II. Implications of derivatives for the monetary transmission mechanism

By allowing individual economic agents to transform their financial exposures cheaply and quickly, derivatives have the potential to modify their sensitivity to interest rate and exchange rate changes and thus alter the response of individual agents to monetary policy actions. But, even if developed derivatives markets allow the incidence of such actions to be shifted among agents, not all agents can globally and simultaneously escape it; anyone seeking to shed risk must find a counterparty willing to bear it. The economy as a whole cannot, therefore, be sheltered from the effects of an interest or exchange rate change through recourse to derivatives. As a result, derivatives do not diminish the ultimate control that monetary policy has over the level of inflation.

Derivatives may, however, change the relative importance of the three channels through which monetary policy is usually considered to operate - the interest rate channel, the exchange rate channel, and the credit channel. They may also affect the **speed and the extent of the transmission** of monetary policy actions to the level of spending and, in turn, inflation.

Regarding the **interest rate channel**, the existence of derivative instruments does not in any significant way impede monetary authorities' ability to set short-term interest rates at desired levels. Moreover, changes in interest rates will continue to affect spending decisions based on marginal costs just as before. In other words, the **substitution effect** that is part of the interest rate channel should remain unchanged.

However, the existence of derivatives may affect the interest rate channel in two other ways. First, derivatives may increase somewhat the already rapid speed with which monetary policy actions affect interest rates along the maturity spectrum. Derivatives likely increase the substitutability of financial assets and, because their low transaction costs facilitate leverage, allow market views to be expressed more vigorously. Second, derivatives might affect the link between interest rates and aggregate spending because the trading of risk and/or return characteristics can change

the way in which monetary policy actions influence the distribution of **income and wealth.** The way in which this link might be affected depends upon the extent to which counterparties to derivative contracts have different degrees of risk aversion and propensities to spend. If those who bear the risks in these contracts have lower propensities to spend out of current income and wealth than those that hedge, derivatives may delay or reduce the effect of a given interest rate change. In effect, the temporary income transfer to hedgers, whose cash flows and spending plans will be unaffected by interest rate changes, need not cause a countervailing change in spending elsewhere. Ultimately, empirical work will be needed to assess whether, and to what extent, the risk transfers that take place in derivatives markets have affected the aggregate propensity to spend out of income and wealth or have affected in other ways the speed or extent of the transmission of interest rate changes to the real economy. However, to the extent that such changes have occurred, it should be possible to adjust policy to ensure that the desired effect on target variables is achieved.

The increased asset substitutability resulting from the growth of derivatives markets may have strengthened the **exchange rate channel**. Changes in the differential between domestic and foreign interest rates may now produce larger changes in the exchange rate, implying a greater role for exchange rates in the transmission mechanism. On the other hand, derivative instruments have further expanded agents' ability to shift the incidence of exchange rate changes, complementing their long-standing ability to hedge against exchange rate movements in forward markets. This enables them, at least partially, to insulate their existing investment or consumption plans from exchange rate changes and may weaken the exchange rate channel in the short run if the exchange rate risk is sold to less risk-averse agents whose spending decisions are less affected by exchange rate changes. The extension of hedging contracts to longer maturities, notably through the currency swap market, may have further dampened this aspect of the exchange rate channel. However, in the long run, exporting firms cannot insulate their production decisions from changes in relative prices brought about by exchange rate movements.

It is worth noting that the role of the exchange rate channel depends on the degree of openness of the economy and on the extent to which flexibility in the effective exchange rate is accepted by the monetary authorities. For countries within completely fixed-rate or narrow band regimes, an additional issue to be considered is the effect of derivatives on the ability of policy to hold the exchange rate constant (see section IV below).

As noted above, the exchange rate and interest rate channels interact with one another. To the extent that derivatives facilitate asset substitution between different maturities in different currencies, a monetary policy decision which changes the yield curve in one currency may affect the yield curve of other currencies. This could modify the exchange rate channel of the **international transmission** of monetary policy actions, perhaps adding another dimension to this channel - a direct link between the interest rate expectations of financial market participants in different national markets. While derivatives would not be the cause of this expectational link, they may well accentuate it.

The **credit channel** relies essentially on market imperfections to transmit a monetary policy action to aggregate demand. These imperfections, in turn, result from information asymmetries and, to a lesser extent nowadays, regulatory restrictions. Theoretically, derivatives can widen firms' access to funding sources in two ways. First, the attachment of derivatives to the securities of a firm already having some direct access to securities markets can improve the supply and dissemination of information about the firm, and lead in turn to still more funding opportunities. Second, derivatives can reduce the risks associated with credit extension by allowing banks and investors to unbundle and hedge the various risk components attached to their assets, and by allowing firms to reduce the business risks inherent in their operations. By reducing market imperfections in these ways, derivatives may have decreased the importance of the credit channel relative to the other channels of monetary policy. However, to the extent that public disclosure has not kept pace with financial trading and risk management practices, potential lenders or investors may have greater difficulties assessing a firm's prospects. Such asymmetry of information has the potential to offset some of these improvements.[4]

III. Impact of derivatives on monetary policy indicators

Monetary policy indicators are used by monetary authorities to help judge the appropriateness of policy actions. A distinction can be made between the impact of derivatives on traditional indicators, and the new information that derivatives might provide to central banks that could be useful in conducting monetary policy.

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[4] Proposals for improved public disclosure are discussed in the "Fisher Report", see footnote 1.

(i) Impact on traditional indicators

Traditional indicators fall into two broad categories: quantitative indicators, such as monetary and credit aggregates, and price indicators, such as exchange rates, interest rates and other asset prices.

As regards **monetary aggregates**, the existence and growing use of derivatives may have an impact on the stock of money balances, either by changing the demand for money services or by making non-money financial assets closer substitutes for traditional money. This may to some extent undermine the indicator function of traditionally defined and measured monetary aggregates. There is, however, so far no empirical evidence that this effect has been quantitatively significant, in particular in comparison with other factors affecting money demand.

The impact of derivatives on **narrowly defined money** will depend on the way they affect agents' transactions, precautionary and speculative motives for holding money. Derivatives provide opportunities for effecting financial transactions with less "cash"; this should - *ceteris paribus* - reduce the demand for transactions balances. However, such demand might increase if the volume of financial transactions (and, possibly, the level of economic activity) expands in response to new financial opportunities. Precautionary money demand may likewise be affected by countervailing influences, as hedgers may find the variability of their incomes decreased whereas speculators may observe the opposite, leaving the net impact uncertain. Lastly, to the extent that derivatives enable capital risk in fixed income securities to be hedged, or a desired level of speculative exposure to be realised with less cash, the speculative demand for cash balances (which is already likely to be quite small) should be reduced.

Concerning the impact on the demand for **broadly defined money**, derivatives provide a low cost means of hedging the market risk of traded assets and of transforming risk bearing assets into lower risk assets. Derivatives thus facilitate the creation of synthetic assets[5] that are closer substitutes for the interest bearing components of broad monetary aggregates. The resulting increase in asset substitutability may change the information content of broad monetary aggregates, but in ways that are difficult to predict.

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[5] For instance, a portfolio of stocks, when combined with stock index futures, can be transformed into a synthetic asset which replicates the pay-off of an interest-rate bearing instrument, such as a term deposit.

The impact of derivatives on **credit aggregates** is likely to be affected by both supply and demand considerations. On the supply side, derivatives enable banks and credit institutions to handle more easily a mismatch in the maturities and/or mode of remuneration of their assets and liabilities, thereby allowing them to provide credit more flexibly and on terms that better fit the needs of their customers. This might lead to a higher level of bank credit being supplied over time. Conversely, if derivatives facilitate access to disintermediated credit, the impact might be in the opposite direction. There is a similar ambiguity with respect to the effect of derivatives on the demand for credit by economic agents over the course of an economic cycle. By reducing uncertainty about future cash flows, derivatives may reduce the demand for credit lines. However, this may be offset by a greater willingness to take on debt to finance longer-term investment.

Concerning **price indicators** (mainly interest rates and exchange rates, but also other asset prices such as those of shares and commodities), derivatives could reduce their usefulness if they have introduced greater volatility in asset prices. However, there is no substantive evidence to suggest that this has been the case in normal times. In times of stress, although derivatives may amplify volatility, price indicators may still convey important information in so far as they may reveal major changes in sentiment or liquidity pressures.

Derivatives facilitate the separate management of interest rate and currency risk and, together with enhanced asset substitutability, may have contributed to increased foreign investment in domestic money and capital markets. This may have altered the relationship between recorded long-term cross-border capital flows and exchange rates and interest rates, and may entail a need to monitor more closely than before exchange rates, short-term interest rates and long-term interest rates as a set.

(ii) Derivatives markets as providers of new information for central banks

Although derivatives may marginally distort traditional indicators, they may also provide central banks with new opportunities for gauging market sentiment.

In general, **futures and forward-type markets** yield information on market views regarding the expected values of a wide range of asset prices, notably interest and exchange rates at various time horizons. While similar information can also be derived from cash market instruments (e.g. implied forward interest rates from the yield curve), futures markets may be more liquid than cash markets, so that information in the former may be superior to that in the latter. Relevant price information is also in some cases

more readily available from futures than from comparable cash markets. It is important to recognise that readings on future prices, regardless of the source, may be contaminated by time-varying risk premia.

In contrast, **options markets** do provide new information. Options prices can be used to estimate a summary measure of market views on the expected volatility of asset prices and exchange rates. A rise in this implied volatility can be interpreted as indicating market expectations of larger fluctuations in the price of the underlying asset in the future or greater uncertainty about the level of such asset prices expected to prevail in the future. Other data derived from options markets may provide complementary information on the shape of the distribution of expectations about prices changes and may give early indications of changes in market perceptions that cannot be obtained from the relevant futures markets.

The report summarises a set of indicators which can be drawn from derivatives markets (see table on page 40) and which central banks can monitor in order to assess market sentiment on the direction and volatility of exchange rates, and short and long-term interest rates. Although experience shows that these indicators do not have good predictive power, they do provide insights about market expectations.

IV. Implications of derivatives markets for the instruments of central banks

The growth of derivatives markets may have some implications for the efficacy with which traditional monetary policy instruments can be used. At the same time, derivatives may provide central banks with additional operational instruments.

(i) Implications for traditional monetary policy instruments

Derivative markets should not affect the ability of central banks to set a desired level of short-term interest rates. However, their implications for the effectiveness of sterilised foreign exchange market intervention, and for the defence of an exchange rate target, could be more substantial.

The capacity of central banks to set a given level of **short-term interest rates** is based on their status as a monopoly supplier of the ultimate means of settlement. This status is unaffected by the growth of derivatives markets. Moreover, by enabling agents to react more quickly, derivatives may make the yield curve more responsive to central bank signals. This may facilitate central banks' ability to influence particular interest rates at the short end of the yield curve, provided its signals carry credibility.

Derivatives may, however, modify commercial banks' demand schedule for central bank reserves by affecting the pattern of transactions and thus the demand for precautionary or required reserves. In any case, central banks will be able to keep control of the price of central bank reserves as long as some demand for such reserves remains.

The implications of the growth of derivatives markets for the effectiveness of **foreign exchange intervention** are ambiguous. Derivatives are one factor contributing to increase international capital mobility and, hence, to the potential size of short-term flows into and out of particular currencies. Official interventions that are viewed as not being in line with fundamentals, and therefore not credible, may be overwhelmed by the scale of such private sector flows. However, official interventions that market participants view as credible may potentially be reinforced by market flows that complement the intervention.

The development and growth of currency option markets may affect the **defence of an exchange rate target** by making it more difficult to anticipate the timing and extent of selling pressures. Purchases by hedgers or speculators of put options on a currency expected to weaken will initially place less pressure on the exchange rate than spot or forward sales of the currency in the same notional amount and may initially slow down the outbreak of a crisis. However, any additional weakening of the currency will provoke spot or forward sales of the currency, related not only to new transactions but also to the need for options writers, principally intermediaries, to hedge their options portfolios.[6] As a result, selling pressures may cumulate quite quickly as existing options positions come closer to being "in-the-money". The potential significance of this problem depends on the extent to which options are used. So far, options transactions, although growing rapidly, account for a small share of total foreign exchange transactions and are therefore unlikely significantly to affect the ability of central banks to defend an exchange rate target.

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[6] In general, option writers hedge their portfolios dynamically using delta hedging which protects the value of a portfolio of written options against small variations in the price of the underlying asset. It is done, in the case of a sold call (put) option, by establishing a long (short) position in the asset to be delivered (received) equal in proportion to the option's delta value, defined as its sensitivity to small variations in the price of the underlying asset.

(ii) Potential operational use of derivatives

The use of derivatives for intervention purposes in foreign exchange or interest rate markets may offer some advantages to central banks, but it also has drawbacks. The balance of these advantages and drawbacks is likely to depend on the structure of the relevant financial markets, the operational procedures of individual central banks, and the circumstances at hand.

Intervening with derivatives has three possible **advantages**. First, interventions in currency derivatives can, in principle, enable a central bank to extend support of the domestic currency beyond the current level of gross reserves. Second, interventions in derivatives markets have no material impact on the central bank's balance sheet; this prevents potential problems of "sterilisation" associated with more traditional forms of intervention. Third, intervention in option markets could deflect hedging pressures if the central bank sold options that are in short supply. Such intervention could also have a signalling effect to the extent that it reduces the level of implied volatility, although further examination would be required to assess the influence of such a reduction on the delta hedging of existing options positions.

The use of derivatives for intervention purposes can also have important **drawbacks**, some of which are related to the fact that central bank balance sheets are not affected. First, some derivative markets (e.g. OTC options markets other than for the principal currencies) may be too thin to support such intervention. Some also have so few market-makers that central bank intervention may induce them to take interventions into account in their own pricing and positioning decisions (thus introducing "moral hazard" risks). Second, if reserve levels pose no constraint on intervention, the potential losses for the central bank associated with intervention in derivatives markets could be heavier than they would otherwise be. Third, in some cases, the use of derivatives to extend the scope of intervention might be perceived as a way of postponing difficult decisions about the policies that have a bearing on the fundamental determinants of the exchange rate. Finally, like any official intervention, intervention in derivatives markets would entail some loss of information about market expectations of future price changes contained in market prices. A desire to preserve this information content could argue against expanding intervention to a wider range of markets.

Conclusion

Although highly prominent, derivatives are only part of the process of financial innovation that has been gathering speed over the past twenty years. It is therefore not surprising that many of the implications of the growth in derivatives markets for the economy and monetary policy are similar to those of other factors involved in the same process, and that they are difficult to isolate.

As with other features of financial innovation, the growing use of derivatives should help promote more efficient resource allocation and strengthen the economy's resilience to shocks.

The limited evidence available suggests that developments in derivatives markets are unlikely to have altered significantly the transmission channels of monetary policy or the efficacy of traditional monetary instruments. Although derivatives may alter the information content of the monetary and credit indicators currently used by central banks, it is not yet clear that this impact has been quantitatively significant. Moreover, derivatives may provide central banks with additional information to guide their monetary policies, as well as additional tools for implementing them.

Derivatives are much more a consequence than a cause of instability in exchange and interest rates, although in times of stress they may contribute temporarily to increased asset price volatility. Consequently, in a derivatives-influenced environment, central banks will need to take greater care to ensure that their policies do not contribute to uncertainty, but rather facilitate the formation of stable non-inflationary expectations. This is most effectively accomplished by a clear and continuing commitment to price stability.

I. Implications of derivatives for the environment in which monetary policy operates

This chapter addresses the extent to which the large-scale use of financial derivative instruments is likely to have altered the economic and financial market environment in which monetary policy operates. It also tries to assess the degree to which such change needs to be taken into account in the setting and operation of monetary policy. Given the primary goal of monetary policy, one question is the possible effect of the use of derivatives on aggregate demand and inflation. But in addition, there are questions concerning the stability, or instability, of the real economy, of asset prices and of financial markets in general, any or all of which could conceivably complicate the setting and implementation of monetary policy.

1.1 Economic functions of derivatives[7]

1.1.1 Risk transfer and "unbundling"

The primary function of financial derivatives is to transfer price risks associated with fluctuations in interest rates, exchange rates or other asset prices. Two attributes of derivatives facilitate risk transfer: their capacity to price and trade separately (i.e. to unbundle) the various elements of price risk embodied in underlying assets, and the leverage they generate by allowing these risks to be traded without the underlying assets having to be acquired or exchanged. The ability of derivatives to unbundle risks enables agents using them to tailor their risk exposures more closely to their preferences or other constraints. Their leverage makes it possible to do so on a considerable scale with relatively limited initial cash outlays and at low transaction costs.

These features make derivatives a highly efficient means of hedging or adopting risk exposures. For instance, a bank with a mismatch in the maturity of its assets and liabilities could use derivatives to hedge efficiently the interest rate risk inherent in its

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7 For a description of the basic nature and uses of derivatives see e.g. *Derivatives: Practices and Principles,* Group of Thirty, 1993; *Recent Developments in International Interbank Relations* (the "Promisel" Report), ECSC/BIS, 1992, and *The Measurement of Market Size and Macroprudential Risk in Derivatives Markets* (the "Brockmeijer" Report), ECSC/BIS, forthcoming. An earlier report, *Recent Innovations in International Banking* (the "Cross" Report), ECSC/BIS, 1986, discusses the incentives for and implications of financial innovation, including derivatives.

position. In the absence of derivatives, an equivalent interest rate risk management strategy would require either the restructuring of the bank's balance sheet, potentially at disadvantageous terms, or the addition of assets or liabilities with offsetting maturities, with more severe consequences for the bank's exposure to credit risk (and capital costs). While an equivalent transfer of risk could have been accomplished by undertaking transactions in the underlying cash markets, it might not have been contemplated in the absence of derivatives given the associated capital and transaction costs.

1.1.2 Greatly increased trading opportunities

While they do not in theory offer anything fundamentally new, derivatives have in practice dramatically expanded the possibilities for trading, hedging and investing in financial markets. A derivative contract can be tied to any observable (or traded) price or performance feature of an underlying asset, or can combine these features to create securities with pay-off characteristics not otherwise on offer in the market place.[8] In economic theory, this property is referred to as *market completion.*[9] In practice, derivatives expand trading or hedging opportunities principally because they can create pay-off characteristics much more cheaply than could be generated by a combination of underlying securities.

Another way in which derivatives expand trading opportunities is that they can be notionally attached to underlying assets without the contracting parties having the underlying to hand, or without there being an intent to acquire or shed the underlying asset. As a consequence, the development of derivatives markets has meant that the gross positions related to an underlying asset need not be constrained by the stock of that underlying asset. It should be noted that any financial market that allows for the temporary borrowing of securities to meet the delivery obligations associated with short selling shares this property.

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[8] The pay-off characteristics of a derivative contract reflect the value assumed by the contract as a linear or non-linear function of possible values of the underlying assets.

[9] The theoretical notion of complete markets describes a world in which there exist securities with a unique pay-off for each and every state of the world. In such a world, all states (events) can be insured.

1.1.3 Improved pricing efficiency

Derivatives can improve the process of price discovery[10] and the efficiency with which existing assets are priced. First, to the extent that derivatives can be used to create pay-off structures which, because of transaction costs or other frictions, are not currently marketed, they may reveal prices for risks which were not previously priced separately. Such prices will generally be relevant for the pricing of other traded risks and should improve the precision and efficiency with which they are priced.

Secondly, derivatives can improve the efficiency with which prices reflect new information and market views. For example, a derivative contract for an asset currently traded in fragmented markets would help to centralise information relevant to the pricing of that asset. This applies in particular to exchange-traded derivative instruments. In addition, if it is cheaper to transact in the derivatives than in the cash market, the cost of incorporating new information into prices will be reduced. Finally, if derivatives markets centralise and reflect new information more rapidly than cash markets, they may attract a higher level of liquidity than the spot market.[11] This could make derivatives prices informationally superior to cash market prices.

1.1.4 Increased asset substitutability

Derivatives are also likely to increase asset substitutability.[12] The ability of individual investors to remove and to trade separately different risk attributes can make the "bundled" versions of underlying assets more substitutable in a portfolio. For example, government securities in different countries can seem more alike once the exchange rate risk is stripped out of them. Moreover, derivatives can be used to gain exposures to, or arbitrage, underlying assets at lower transaction costs, in part because they require a smaller principal investment than trading in underlying assets. This facilitates arbitrage directly and also reduces the cost of hedging the price risks that agents do not wish to carry. Increased arbitrage may reduce the risk premia that are attached to components of financial asset prices by reducing mispricing and by increasing incentives for portfolio diversification. By increasing the mobility of capital, this has at least the potential for further co-movement in asset prices. This does not

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10 In times of stress, if derivatives exacerbate price volatility, they can also weaken price discovery.

11 There is at present no systematic evidence that the development of derivatives markets has caused a diversion of trading from cash markets.

12 The substitutability between two assets may be said to be high when a small change in the expected return on one asset induces a large change in the demand for the other asset.

mean that domestic and foreign asset prices - or short-term and long-term interest rates - should always move together in the same direction or to the same extent.

1.2 Macroeconomic implications of the influence of derivatives on the behaviour of economic agents

Derivatives permit end-users and market-makers to manage more effectively and efficiently the market risks present in their activities. These improved risk management procedures may well have effects which, in the aggregate, could have implications for the behaviour of the macro economy. In principle, such effects include: a once-for-all shift in the level of actual or potential output with possible implications for inflation, a modification of the long-term trend rate of growth, or a change in the cyclical properties of the economy. In practice, it is likely to prove difficult to identify such effects in economic data.

Firms in the non-financial **corporate sector** generally face variability in their cash flows, borrowing costs and investment opportunities. Derivatives can be used to hedge some of this variability and thus increase firms' resilience in the face of shocks. This could encourage fixed capital investment. For example, if there are constraints on a firm's access to external financing, variability in its internal cash flows will affect the amount of funds available for investment purposes. If the firm has "lumpy" investment plans, the use of derivatives to reduce the variability of cash flows could reduce the risk that these plans might have to be delayed or shelved altogether. In addition, a smoother cash flow might improve the credit standing of the firm, increase its access to external finance and reduce its financing costs. Alternatively, if the firm is already unconstrained in its access to external finance, it might nevertheless be concerned about interest rate variability and use derivatives to co-ordinate fluctuations in its cash flow with those in its debt servicing, thus further reducing apparent instability in the value of the firm.

In addition, across firms as a whole, a freeing-up and evening-out of financing constraints might help improve overall resource allocation in the economy. On the other hand, poor internal controls over the use of derivatives has in a few recent instances led to large and potentially destabilising losses. There are also some concerns that they may encourage over-indebtedness, although over-indebtedness can occur in firms that do not make use of derivatives.

Although they can rarely use them directly, **households** are gaining increased access to derivatives. For example, via the use of derivatives by financial

intermediaries, households in some countries are benefiting from so-called guaranteed equity income schemes, as well as greater access to fixed rate mortgages which reduce the risks for borrowers. Thus, qualitatively similar effects on behaviour would seem likely to follow, namely smoother spending patterns and, possibly, increased investment in housing.

In sum, the increasing use of derivatives implies some presumption of increased demand in the economy, but aggregate supply may also be increased to the extent that fixed investment is stimulated and resources allocated more efficiently. Thus the net effect on the inflationary bias of the economy will probably be insignificant. Similarly, while the use of derivatives should be beneficial for the stability and resilience of the economy in the face of shocks, this effect could in certain circumstances be tempered by destabilising influences arising in the financial sector, as well as by uninformed misuse of derivatives elsewhere in the economy.

1.3 Implications of derivatives for the functioning of financial markets

1.3.1 In normal market conditions

The impact of derivatives on market functioning may differ between normal and distressed - or crisis - conditions. In normal market conditions, the addition of derivative instruments in an incomplete market setting seems likely to facilitate price discovery and improve risk-sharing. This has the following **positive effects**:

- it enhances liquidity and efficiency in the market for the underlying asset. The effects on market liquidity of opening derivatives markets can be measured by the changes in subsequent bid-ask spreads and trading volumes. The empirical evidence generally suggests that bid-ask spreads on the underlying securities decrease after the listing of derivatives. More specifically, the liquidity enhancing impact of derivatives has been observed in a number of government debt markets following the introduction of futures contracts.[13]

- derivatives have also greatly facilitated arbitrage, hedging, funding and investment strategies that straddle various market segments. From the perspective of the financial system's resilience to market disturbance, such linkages and the availability of substitute hedging markets can act as a safety valve. By offering alternative sources of supply and demand, price changes may

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13 See Annex 1 on the "Effects of derivatives products on the underlying markets" in the compendium of annexes prepared by central banks for the present report.

be transmitted from one market to another; this may also help to diffuse disturbances.

- for the economy as a whole, derivatives can facilitate a redistribution of risk. To the extent that risk is shifted from agents less capable of bearing it to others more able to do so, there is likely to be a reduction in the fragility of the financial system. There is, in other words, a net gain to the economy, as greater financial market resilience, both domestically and internationally, should help disperse shocks.

In normal market conditions, these considerations suggest that derivatives may help keep prices in line with fundamentals and help stabilise financial markets. Moreover, large scale use of derivatives may improve the overall risk bearing capacity of financial markets and of the economy more generally. For some countries, an implication for monetary policy is that it should be possible - when conditions warrant it - to apply monetary policy more forcefully. That is, with more resilient firms and financial markets, once a decision to raise interest rates has been taken, it may be possible to raise rates higher, or for longer, with less concern that this leads to financial market discontinuities and bankruptcies. The decision by a central bank as to whether such forceful action is appropriate will depend on the assessment of the impact of derivatives on the monetary transmission mechanism, the subject of the next chapter.

1.3.2 Role of derivatives in periods of market stress

The most obvious feature of a period of market stress is a sudden, very sharp and often short-lived, movement in a set of asset prices - normally a fall. Examples in recent years include the sudden world-wide collapse in equity prices in October 1987, the turbulence in currency markets in the summer and autumn of 1992 and 1993, and the decline in bond prices in the spring of 1994.[14] During periods of market turbulence, the stability of the financial system is a concern for central banks. However, large and sudden changes in asset prices clearly have implications for monetary policy as well.

Episodes of market turbulence cannot be evaluated without reference to some longer-term context. They are usually preceded by a period in which the market prices of the assets concerned surpass levels justified by fundamentals. An unexpected event,

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[14] See Annexes 2 to 5 in the separate compendium of annexes for a discussion of the role of derivatives in some of these episodes.

or a change in market participants' views and expectations, may then cause a reassessment of current price levels, triggering large and often disorderly movements in prices which may in some instances involve overshooting in the opposite direction for a time.

Taking first the build-up phase leading to episodes of financial market turbulence, it is possible in theory to think of several ways in which derivatives may have been a contributing factor. In practice, however, their importance is not entirely clear.

- Given their leverage and low transactions costs, derivatives facilitate the taking of speculative positions. Thus, they can assist uninformed investors in taking market positions, e.g. through the medium of institutional retail investment vehicles, and increase the activities of those expecting to exit markets before they reverse. This could reinforce "bullish" markets. However, derivatives do not oblige anyone to take such positions; moreover, derivatives may make it easier for informed investors to take a position against prevailing market sentiment (for example, by facilitating short-selling of assets perceived to be over-valued).

- Derivatives may make possible more rapid intra-day reaction to new information on fundamentals. This rapidity may lead to overshooting in the short term. But there is little presumption that the direction of such reactions would not be "right" and it is also not clear how such very short-run mispricing could be carried over, in the same direction, for an extended period.

- Subsumed in both of the above is so-called "imitative trading" (purchasing in a rising market and selling in a falling one) by poorly informed investors that could involve positive feed-back effects on prices. This typically occurs when investors trade on the perceived expectations of other investors. In principle, dynamic hedging activities could provoke imitative trading to the extent that they are misinterpreted as representing position-taking by informed investors.

All in all, it is difficult to see derivatives playing a causal role in asset price misalignments. Similarly, derivatives markets are not likely to be the trigger mechanism for the abrupt changes in market sentiment that presage sudden and large price movements. As to the size and sharpness of the subsequent asset price movements, derivatives may play a greater role. From a macroeconomic perspective, this should not necessarily be thought of as unfortunate since the resulting movement of prices is towards, rather than away from, equilibrium.

Nonetheless, derivatives might lead to some degree of overshooting in certain circumstances. Aspects that could adversely affect market dynamics include:

- dynamic hedging of option exposures would typically involve heavier trading in the underlying assets in periods of stress than during periods of relative stability:

sharper price movements translate into larger modifications of the delta of options and therefore heavier purchases (if prices rise) or sales (if prices fall).[15] If many market participants rely on dynamic hedging of their derivatives exposures, their hedging needs could exhaust cash market liquidity, which could further exacerbate price movements. Traditional stop-loss orders and portfolio insurance strategies can have the same effect on underlying prices as dynamic hedging.

- a concentration of option strike prices at perceived critical asset price or exchange rate levels (e.g. at "support levels" as identified by technical analysis) can elicit additional selling pressures when prices approach or reach such levels.

- margin and collateral calls on derivatives increase in times of heightened volatility: in a context of sharply declining prices, underlying positions may have to be liquidated to meet collateral or margin requirements.

- hedging overhangs might occur: the use of particular products or markets for hedging in risk management strategies may be highly effective in normal two-way markets but may become impossible if undertaken by many market participants simultaneously during a market break. Such hedging overhangs could exacerbate price movements.

- in times of stress, derivatives may increase the valuation uncertainties which inevitably arise in such periods. In part, this can be ascribed to general difficulties in understanding, pricing and managing inherently complex instruments. The statistical and mathematical techniques which underlie pricing and trading strategies are based on the assumption that historical distributions of price changes are reasonable guides to future volatility. In situations of crisis, such assumptions can become invalid.

It is at least theoretically possible that during periods of turbulence all of the above mechanisms could reinforce each other.[16] And given the linkages among markets both domestically and internationally, a price disruption in one market could rapidly affect others.

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15 See the compendium of annexes for further development. Annex 2 describes dynamic hedging techniques and Annex 3 discusses the role of portfolio insurance strategies in the October 1987 stock market decline. Annex 5 suggests that the hedging of portfolios of mortgage-backed securities may have magnified the increase in long-term rates which accompanied the Federal Reserve's policy tightening in the Spring of 1994.

16 A source of additional volatility is the limited information among market participants of the risk exposures assumed by financial intermediaries in their derivatives and other trading activities. Improved public disclosure of financial risk would increase transparency, strengthen market discipline and promote a better allocation of capital among firms. This should limit the risk of market disturbances being amplified by uncertainties as to the creditworthiness of counterparties. See *A Discussion Paper* on *Public Disclosure of Market and Credit Risks by Financial Intermediaries*, ECSC/BIS, September 1994.

Yet, as noted above, there is little evidence that such phenomena in derivatives markets would necessarily result in an overshooting of prices. Indeed, by helping to transmit price changes to a wider variety of markets, derivatives might even help to avoid such an outcome. Lastly, it should be remembered that whether or not the growth of financial derivatives has played a role in exacerbating shocks, derivatives were initially a response to, i.e. a consequence of, the increased volatility of financial markets which began with the growth of international capital mobility in the late 1960s and gained momentum with the breakdown of the Bretton Woods system and the period of high and variable inflation that followed the first oil price shock.

1.3.3 Implications of asset price volatility for monetary policy

The potential for asset price misalignment and subsequent turbulence, whether exacerbated by derivatives or not, has implications for monetary policy. An obvious issue is whether monetary policy can prevent asset price misalignments from appearing in the first place. In general, appropriate anti-inflationary policy settings should discourage asset price inflation. However, at times there may be a short-term conflict between the policy requirements of maintaining low inflation and the policy stance that might seem appropriate in the light of asset price considerations. For example, some asset prices might begin to rise sharply in a situation where general inflation was well under control and the real economy was still weak. Or, following a boom, some asset prices might decline sharply, threatening financial stability, while general inflation was still not under sufficient control.

Even in such circumstances, however, there is nothing to be gained and much to be lost by allowing monetary policy to deviate from a course consistent with price stability. Were the dilemma to threaten to become acute, the implication is that other, more direct, actions would have to be considered, including perhaps the authorities making their views about the appropriateness of asset prices more clearly known to the markets. One problem with this, however, is that it is not always easy to recognise an asset price misalignment clearly, especially in its early stages when pre-emptive actions would be most appropriate. But this argues all the more strongly for trying to head off the possibility of such bubbles arising in the first instance, for example by raising interest rates sufficiently early in a recovery.

In conclusion, derivatives **do not cause** sharp asset price movements but may in times of stress **amplify** short run price volatility and possibly accentuate price movements. As for the implications for monetary policy, derivatives do not interfere with the pursuit of price stability. However, at times of stress, consideration of asset

market conditions may influence the tactics of monetary policy, such as the timing of policy action. The most effective contribution that central banks can make to avoid times of stress in the first place is to follow a strategy that is predictable and well-explained to the public, and to implement that strategy in a consistent manner so as to aid the formation of stable non-inflationary expectations. The latter may call for pre-emptive and/or gradual actions as appropriate. However, these tactics should not compromise the objective of price stability.

II. Impact of derivatives on the monetary transmission mechanism

Derivatives allow individual economic agents to transform their financial exposures cheaply and quickly. This enables them, if they choose, to lessen their sensitivity to interest rate and exchange rate changes and can thus alter the response of individual economic agents to monetary policy actions and shift the incidence of such actions among them. This may change the way in which monetary policy actions are transmitted to the economy in general.[17] But even in the presence of perfectly developed derivatives markets, not all agents can globally[18] and simultaneously escape the effects of a monetary policy action.[19] As a result, derivatives are unlikely to diminish the ultimate control that monetary policy has over inflation.

Broadly speaking, monetary policy is considered to work through three channels: the interest rate channel, the exchange rate channel, and the credit channel. Derivatives may change the relative importance of these channels in the transmission mechanism. However, they will not simultaneously prevent all three channels from working.

2.1 The interest rate channel

The interest rate channel refers to the mechanism whereby monetary policy actions affect real economic activity and inflation through their effect on interest rates and the relative rates of return on other assets. The central bank has monopoly power over the final means of payment in an economy, and this imparts to its policy actions a direct influence on interest rates at the very short end of the maturity spectrum. Changes in short-term interest rates initiated by the central bank are transmitted to other interest rates through expectations and substitution effects. A widespread increase in interest rates affects aggregate demand by making it more expensive at the margin for economic agents to finance investment and consumption plans, by reducing the cash

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17 The data gathering recommended in the report on *The Measurement of Market Size and Macroprudential Risks in Derivatives Markets* (see footnote 1) will give some indications on the redistribution of risk resulting from derivatives activity.

18 In theory all risk for an individual economy could be transferred abroad. This is most unlikely to happen in practice.

19 In complete markets (see footnote 9), monetary policy would not affect real economic activity but would still affect inflation if the central bank has monopoly power over the final means of payment.

flow of net floating rate debtors, and by reducing the wealth of holders of assets whose payment streams do not rise in line with interest rates. A change in aggregate spending not matched by a change in aggregate supply changes the inflationary pressure extant in an economy.

The existence of derivatives may affect the interest rate channel in two ways. First, by increasing asset substitutability and facilitating arbitrage, derivatives might affect the speed and extent with which short-term interest rate variations are transmitted along the maturity spectrum and to other financial asset prices. Second, by enabling agents that have different propensities to spend out of income and wealth to trade risk and return characteristics - thus altering their financial exposures - derivatives may modify the income and wealth effects resulting from a monetary policy action.

2.1.1 Derivatives and the speed and extent of transmission of policy actions to financial asset prices

The speed and extent with which a monetary policy action is transmitted to real economic variables and inflation depends ultimately on how economic agents adjust their expenditures in response to interest rate changes. However, the speed and extent with which a policy-induced change in short-term interest rates is transmitted to other interest rates and asset prices is also important because it is the impact of these other financial variables on lenders' and borrowers' decisions that ultimately affects their spending behaviour.

The speed of transmission to other rates and asset prices depends on substitution and expectations effects. Both may be affected by derivatives. Derivatives increase asset substitutability and enable agents to adjust the composition of their portfolios more rapidly and at lower cost. In addition, by increasing leverage, derivatives may enable views or expectations to be expressed more vigorously than in the past. This should cause relative asset prices to adjust more speedily to policy-induced changes in short-term interest rates.

Although the role of derivatives in influencing the adjustment of asset prices may be important conceptually, and may have implications for the manner in which policy is implemented, it is unlikely to significantly affect the speed of the transmission process to real variables (and inflation) because the reaction of relative asset prices to a change in short rates has always been quite fast.

2.1.2 Substitution, income and wealth effects of a monetary policy action

Short-term interest rate changes, once transmitted to other interest rates and asset prices that are relevant to agents' decisions, have a direct effect on marginal financial decisions. For example, a rise in marginal borrowing costs will dampen aggregate demand by discouraging decisions to finance current expenditures out of future income through borrowing. The introduction of derivatives, by spurring efficiency gains in financial intermediation, may have resulted in a small once-and-for-all reduction in the level of marginal borrowing costs and may cause an analogous once-off increase in aggregate demand. However, this need not concern monetary authorities. As long as central banks can affect marginal borrowing costs, aggregate demand will ultimately be affected as well: derivatives cannot change the fact that economic agents must be compensated for delaying spending and are willing to pay to advance spending.

It is important to note that - whether or not derivatives exist - a monetary policy action cannot be avoided in the aggregate in a closed system. For example, it is sometimes argued that if agents correctly anticipate a monetary policy action, they can swap their floating rate obligations into fixed rate obligations when interest rates rise, and vice versa when rates decline, thereby avoiding the income and wealth effects of such action. But economic agents in the aggregate cannot simultaneously swap out of floating rate obligations to avoid the consequences of rising interest rates. Someone must hold those obligations, and the floating rate payers' marginal spending decisions would ultimately be affected by rising interest rates.

Although derivatives are unlikely to have much effect on marginal borrowing costs, they may reduce the proportion of current spending and investment plans that is sensitive to changes in marginal borrowing costs. When adjustment costs are high, agents with longer-dated plans may seek cost effective ways of hedging variations in short-term interest rates. To the extent that derivatives reduce the cost of insurance against such events (e.g. in the form of caps on flexible rate debt) or make it easier for some agents to obtain fixed rate finance (e.g. through interest rate swaps), they may allow (i) planning horizons to be extended, and (ii) a larger proportion of plans to be temporarily shielded from short-term interest rate changes. More long-dated plans that are unresponsive to a temporary rise in marginal borrowing costs may then come into

existence.[20] This could delay the impact of a monetary policy action (for as long as contracts protecting existing spending and investment plans last), but would not eliminate it because the marginal borrowing costs affecting new spending plans are unlikely to be affected.

The extent to which derivatives could delay the effect of policy depends on whether the shifting of risk, and thus of the incidence of a policy change, has offsetting effects on the agents involved in the transfer of risk. It seems reasonable to assume that derivatives contracts are mostly struck between heterogeneous agents: in their degree of aversion to bearing risk, in the type of constraints they face, or in their propensity to spend out of income and wealth. For example, a risk averse agent whose spending plans are highly sensitive to changes in short-term interest rates is likely to be willing to compensate a less risk averse agent for bearing the risk of changes in short-term rates. Similarly, if liquidity constraints would force a firm to abandon an investment project if interest rates rose, the firm is likely to seek, and to be willing to pay for, insurance that insulates it from such changes. Their ability to find such insurance will depend on the existence of other agents whose spending plans or liquidity are relatively unconstrained by interest rate changes, or who demand a lower compensation for bearing risk than the benefits that accrue to the firm that seeks insurance.

Derivatives markets provide a venue for localising and matching up individuals that are heterogeneous in these senses. Such matching may lead to constraints being lifted for some agents without a countervailing constraint being imposed elsewhere, and allow spending plans that would otherwise have had to be curtailed by rising borrowing costs to be carried on without there being a coincident reduction in spending by some other agent. Whether or not counterparties to risk-transfer contracts differ sufficiently in a systematic sense for aggregate effects to arise from such differences is an empirical matter.[21] However, to the extent that such effects have occurred, it should be possible to adjust policy to ensure that the desired effect on target variables is achieved.

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[20] A derivatives contract providing the type of insurance described above amounts to the lifting of a liquidity constraint on the agent with long-term plans. If the project has positive net worth over the interest rate cycle, the agent should not normally have had problems raising the funding needed to smooth a temporary cash shortfall. However, liquidity constraints can arise for a variety of reasons, including information asymmetries which make certain creditors unwilling to lend to risky projects when riskless rates rise. See the discussion of the credit channel below.

[21] Data on the types of counterparties to derivatives transactions could provide a starting point for an investigation but would not be sufficient to resolve the question unless further information on their underlying exposures and other characteristics were available. It should also be noted that derivatives are only one (albeit important) expression of the evolving ability of financial markets to provide contracts more suited to agents' needs and which together lessen their sensitivity to their risk

Footnote continued.

In addition to contracts entered into for risk hedging purposes, derivatives contracts are also struck between agents who speculate on future price changes. This activity is likely to be dominated by active traders and will result in income transfers between them. To the extent that the owners whose incomes are affected are similar, these transfers are unlikely to have any effect on aggregate spending. However, speculative transactions may also involve non-financial counterparties whose likelihood of guessing right, and whose ability to bear losses, might be smaller than that of full-time trading or dealing institutions. If such betting systematically transferred wealth to financial institutions, and the propensity to spend out of income and wealth by owners of such institutions differed systematically from that of non-financial speculators, the wealth effects of a rise in interest rates could be affected. However, this line of reasoning relies on strong and unrealistic assumptions. For example, it would seem likely that if one group of economic agents were systematically better at predicting the actions of monetary policy than another group of economic agents, the latter would soon learn to watch the group of informed agents so as to anticipate the timing of monetary policy actions themselves.

2.2 The exchange rate channel

The exchange rate channel of the transmission mechanism rests on the fact that changes in the stance of monetary policy can affect the exchange rate, with, all else equal, a decline in interest rates relative to those in other countries tending generally to lower the foreign exchange value of the currency and a relative rise in interest rates tending to increase it. The significance of the exchange rate channel depends on the openness of the economy, as well as on the extent to which flexibility in the exchange rate is accepted by the monetary authorities. The channel does not depend on an individual exchange rate between the domestic and another currency, but on the domestic currency's exchange rate with all relevant currencies, i.e. the effective exchange rate. For a country that has a fixed exchange rate with all its trading partners, the exchange rate channel does not work. In such cases, as well as for a country within a narrow-band regime with all its trading partners, the question becomes a different one, namely the effect of derivatives on the ability to hold the exchange rate constant (see Chapter IV).

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environment. This suggests that it is likely to be very difficult to identify and separately measure the effect contributed by derivatives markets.

Where there is some flexibility, the exchange rate channel conveys the impact of monetary policy in two ways. First, a change in the exchange rate provokes a reaction in aggregate demand either because of relative wealth effects (the value of assets denominated in the domestic currency will have changed relative to the value of assets denominated in the foreign currency) or because of relative price effects (e.g. the price of domestic production will have changed relative to the price of foreign production). Second, fluctuations in the exchange rate will directly affect the price level because of their impact on the domestic-currency prices of imports.

Derivatives are, in one respect, likely to **strengthen** the impact of the exchange rate channel. By increasing the substitutability of domestic and foreign assets, changes in the differential between domestic and foreign interest rates would now produce proportionately larger changes in the exchange rate.

Conversely, it is well known that domestic entities who sell into or purchase from foreign markets can use derivatives to protect themselves from exchange rate changes by selling the exchange rate risk to an economic agent with an opposite exchange rate exposure or to one whose decisions are unaffected by exchange rate changes. This enables them to insulate their income or wealth from the influence of fluctuations in the exchange rate. The existence of derivatives may therefore **dampen** this aspect of the exchange rate channel. However, in the long run, exporting firms cannot insulate their production decisions from changes in relative prices brought about by exchange rate movements.

To put this latter point in perspective, it is important to note that agents have had the ability to hedge against exchange rate movements in forward markets for many decades. Indeed, this ability to hedge is often cited as one of several reasons why a change in the exchange rate — even when permanent — takes a long time to affect net exports of a country. Thus, although new derivative instruments, notably currency swaps, may facilitate more flexible and longer maturity hedging than traditional forward contracts, it is unlikely that the impact of new derivative products will be large.

The smooth functioning of floating exchange rates may occasionally be impeded by high exchange rate volatility. For countries whose financial and foreign exchange markets have traditionally been unfettered by government regulations, such exchange rate volatility is not a new phenomenon. As in the case of interest rates, the increased substitutability of domestic and foreign assets may either decrease or increase the volatility of exchange rates, with the latter being more probable in highly stressed market conditions. However, whether the magnitude of these effects would be great enough to have serious implications for monetary policy is doubtful.

As noted above, the interest rate channel and the exchange rate channel interact with one another. To the extent that derivatives facilitate asset substitution between different maturities in different currencies, a monetary policy decision that changes the yield curve in one currency may affect the yield curves of other currencies. This could strengthen the exchange rate channel of the international transmission of monetary policy and add another dimension to this channel - a direct link between the expectations of financial market participants in different national markets. Derivatives are not a cause of this expectational link but may well accentuate it.

2.3 The credit channel

The credit channel transmits monetary policy actions to aggregate demand by affecting the volume and composition of credit extended by the banking sector. The credit channel works only when, for some firms and investors, bank loans and other forms of credit are imperfect substitutes. This may be due to market imperfections and, to a lesser extent nowadays, regulatory restrictions. Some firms lack access to funding sources other than banks because it is too costly for private investors to obtain the information necessary to feel comfortable lending to them. In such a situation, if an increase in the riskless rate of interest causes banks to substitute riskless assets for risky loans (e.g. because of adverse selection[22] problems), some firms may be deprived of credit even if they are willing to pay more for it. This may force them to cut back on their spending, thereby reducing aggregate demand.

Theoretically, derivatives can contribute to widening firms' access to alternative funding sources, either by helping to remove the problems associated with asymmetric information or by enabling borrowers as well as lenders to overcome some of the risks arising from financing transactions. These two influences are reviewed below.

2.3.1 Role of derivatives in information about the firm

The credit channel applies mostly to small firms without direct access to securities markets. It is not, however, confined to such firms: even firms that have some established access to securities markets can find their access to bank credit

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22 Adverse selection refers to the risk that borrowers accepted by a bank at a higher interest rate are systematically worse credit risks.

restricted when the return on riskless assets rise. Such firms may also find their access to securitised credit reduced if banks reduce back-up credit lines to them.

The attachment of derivatives to the securities of a firm with some direct access to securities markets can improve the supply and dissemination of information about the firm and enlarge its investor base. Greater interest in the firm's securities also creates incentives for market analysts and rating agencies to produce additional information about it. An improved supply of information should help to reduce the perceived risks involved in lending, thus enabling the firm to raise funds more easily through a wider variety of sources.

However, it should be noted that the growing use of derivatives and other off-balance sheet instruments has reduced, at least for the time being, the transparency of firms' balance sheets. Although reduced transparency affects mainly the financial sector at present, growing use of derivatives in the non-financial sector could counteract some the improvements noted above unless accounting and disclosure standards improve.[23]

2.3.2 Role of derivatives in reducing risks associated with credit extension

Derivatives can reduce the risks associated with credit extension by (i) allowing banks and investors to unbundle and hedge the various risk components of their assets, and (ii) by allowing non-financial firms to reduce the business risks arising from their operations.

The first of these possibilities could improve firms' access to diversified sources of credit if it enables banks to hold only those risks that they have the best ability to assess, while unbundling and separately marketing risks that other investors might be willing to hold. For banks in the aggregate, the risk transformation achieved through unbundling and securitisation can produce some of the risk reduction benefits obtained through more traditional portfolio diversification. As a result, a monetary policy action that raises the riskless rate of return may lessen the extent to which aggregate demand will be affected through the credit channel. For investors, the ability either to reduce the uncertainty of expected rates of return, or to specialise in the holding of specific risk

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[23] Recommendations for improved public disclosure of financial risk exposures are contained in *A Discussion Paper on Public Disclosure of Market and Credit Risks by Financial Intermediaries* (see footnote 1).

characteristics of assets, should expand their demand for securities. This could further tend to reduce the financing constraints imposed by the credit channel.

As for the second of these possibilities, as noted earlier, the acquisition of insurance contracts that hedge against changes in the cost of external finance (or against changes in input or output prices) can enable firms to avoid the expected penalty costs associated with defaults. This reduces their riskiness both to banks and to outside suppliers of funds. This reduced riskiness might also increase their access to external finance.

III. Impact of derivatives on monetary policy indicators

3.1 Impact on traditional indicators

3.1.1 Quantitative indicators

3.1.1.1 Monetary aggregates

The relative usefulness of a particular monetary aggregate as an indicator (and intermediate target) is ultimately an empirical issue. Experience in many countries indicates that the process of disintermediation, encouraged by deregulation and innovation, may be an important factor tending to undermine the usefulness of monetary aggregates as indicators and intermediate targets. What is at issue here is whether the development of derivatives markets has contributed to this process in any significant way.

The growing use of derivatives may have an impact on the stock of money balances, either by changing the demand for money services, or by transforming non-money financial assets which bear price risk into closer substitutes for traditional (risk free) money, or by a combination of both. This can undermine the indicator function of traditional monetary aggregates. To the extent that the demand for money is shifting in an unpredictable way, the empirical foundation of monetary targeting is also called into question.

3.1.1.1.1 Impact on the demand for narrowly defined money

From a microeconomic point of view, an individual's demand for money balances is determined by that agent's transactions, precautionary and speculative motives.

The **transactions demand** for money results from a lack of synchronisation in individual agents' foreseeable inflows and outflows of cash within a planning period. For a known and given structure (frequency and amount) of cash flows, the demand for transactions balances is positively related to the volume and number of transactions. Derivatives can have an impact on the transactions demand for money in two ways. On the one hand, the leverage provided by derivatives should reduce the demand for transactions balances to the extent that non-financial agents substitute derivative operations (which occur without exchange of principal) for cash market operations in the management of price risks. On the other hand, however, increased trade in

derivatives, *ceteris paribus*, could increase the transactions demand for money. As a result, the effect of derivatives on total transactions demand of non-financial agents is ambiguous.

The amount of transactions balances saved in a single operation by a financial agent may be high in absolute terms. However, because participants in financial markets are already efficient users of transactions balances, substitution of derivative operations for cash market transactions is most likely to have only a marginal impact. It seems reasonable to conclude that the net effect of increased derivatives usage on the demand for transactions balances by non-financial and financial agents is likely to be quantitatively small.

The **precautionary demand** for money balances stems from a desire to avoid the inconvenience and penalties associated with unforeseeable inflows or outflows of cash. Although the precautionary demand for money is most likely to be only a relatively small fraction of total money demand, derivatives can affect it in two ways. First, they offer low-cost opportunities for hedging or taking price risks through non-money financial assets. Hedgers may find the variability of their incomes decreased, whereas speculators may observe the opposite. This tends to reduce hedgers', and at the same time increase speculators', precautionary demand for money, leaving the net impact uncertain without specific assumptions about risk preferences and the relative importance of hedging and speculative activities. There is no obvious way of quantifying the size of each effect empirically in the absence of detailed information at the microeconomic level. However, it seems not unreasonable to conclude that the net effect is quantitatively small, even in periods of increased asset-price volatility. Second, futures and standardised options positions are marked to market (normally every business day).[24] This might create greater cash flow uncertainty and could, in principle, increase the precautionary demand for money, especially in a situation of high or increasing asset-price volatility. However, empirical evidence suggests that the bulk of initial margin requirements are met by depositing securities, while variation margin requirements are met by cash deposits. Available evidence for the US market suggest that such daily futures-related flows are small relative to overall financial payments in the economy. The impact of derivatives on the precautionary demand for money is therefore likely to be small.

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[24] Margining is not required by regulation for OTC derivatives that are marked to market. However, the institutions involved in the trading of these instruments increasingly apply margins and are encouraged to do so by supervisors.

The **speculative demand** for money is defined as cash balances held to avoid capital losses in a rising interest rate environment. To the extent that derivatives enable capital losses in fixed income securities to be hedged, or a desired level of speculative exposure to be realised with less cash, the speculative demand for cash balances should be reduced.

In sum, the existence of derivatives provides some opportunities which tend to reduce the demand for cash balances. At the same time, the growing use of these instruments may increase money demand, making it difficult to assess the net impact. However, neither theoretical reasoning nor available empirical evidence strongly support the view that any single combination of the impacts analysed above should lead to a significant change in the demand for narrowly defined money.

3.1.1.1.2 Impact on the demand for broadly defined money

Derivatives provide low-cost means of hedging the market risk of traded assets, effectively creating synthetic assets that are closer substitutes for the interest bearing components of broad monetary aggregates.[25] The degree of market risk in a financial asset may therefore have become less useful in distinguishing between money and capital.[26] This would make it more difficult to define and empirically measure a theoretically meaningful monetary aggregate. However, this is not a new problem: for example, it is not clear from a priori reasoning whether interest-bearing assets protected from market risk (such as time deposits, hedged bonds or other synthetic assets) are held for transactions or savings purposes. Were such assets held principally for transactions purposes, traditional broad monetary aggregates would increasingly understate the "true" stock of assets providing money services, and would be more loosely related to final demand. On the other hand, if the savings motive dominates, the share of the components of broad monetary aggregates that reflects the savings motive would diminish, such that broad aggregates would increasingly reflect transactions balances.

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[25] For instance, a portfolio of stocks, when combined with stock index futures, can be transformed into a synthetic asset which replicates the pay-off characteristics of e.g. a term deposit.

[26] In this context, market risk is defined as the risk of capital loss, and money is defined to include only assets that are protected from the risk of capital loss. Capital is defined to include assets that are held for savings purposes (rather than for their moneyness characteristics) and which carry market risk. It should be noted, however, that this distinction is not clear-cut: for example, long-term deposits can be used for investment as well as for liquidity purposes.

The relative importance of these motives may change over time and is not easily identifiable empirically. As a result, the increased asset substitutability brought about by derivatives may change the information content of broad monetary aggregates and at the same time increase the volatility of empirical measures of a broader money stock, but in ways that are difficult to predict.

To sum up, the growing use of derivatives seems likely to have divergent effects on the components of monetary aggregates. The impact of derivatives on the demand for narrow money seems likely to be insignificant. For broad money, the effect on both the level of demand and the predictability of its relationship with real activity may be more significant. However, this should not lead to the conclusion that narrowly defined monetary aggregates would in general become superior to broader ones.[27]

3.1.1.2 Credit aggregates

The relative usefulness of a particular credit aggregate as an indicator or as an intermediate target is essentially and ultimately an empirical issue. The behaviour of credit aggregates is more likely to depend on broad structural factors, such as financial system deregulation and innovation, than on the growth of derivatives markets per se.

Derivatives can be expected to affect the supply of and demand for various components of credit. On the supply side, derivatives enable banking institutions to handle more easily a mismatch in the maturities and/or modes of remuneration of their assets and liabilities. This should enable banks to provide credit more flexibly and at terms that better fit the needs of their clients. Moreover, derivatives may enable credit institutions to circumvent regulatory constraints on their balance sheets. Consequently, any credit aggregate based on institutional criteria may lose some of its usefulness.

Derivatives can be expected to have two contrasting effects on the demand for credit over the business cycle. On the one hand, the improved ability to manage cashflow variability with derivatives may reduce the use of lines of credit to smooth transitory income fluctuations. On the other hand, if derivatives, by reducing uncertainty at the micro-level, help to lengthen planning horizons, borrowers may become less concerned about bearing heavier debt burdens over the cycle.

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[27] In Germany, for example, money stocks in the narrower definitions M1 and M2 are subject to strong fluctuations. This is first and foremost a reflection of the cyclical movements in short-term interest rates which affect M3 to a much lesser degree.

Derivatives can also have opposite one-off effects on credit demand. For example, an improved ability to manage risks may lead economic agents to operate with permanently higher leverage. However, credit provided at terms that better suit agents' needs could permit a given level of activity to be carried on with a lower overall level of credit than in the past.

3.1.2 Price indicators

Central banks assign an important role to various price indicators - other than direct measures of inflation - in the day-to-day conduct of monetary policy because they provide readily available information about market expectations, are closely watched by market participants and, ultimately, are linked to overall price stability. Exchange rates influence the domestic price level through the prices of imported goods and services, and do so whether or not they are an intermediate objective of monetary policy. Long-term rates (or the differential between long and short-term rates) may indicate market participants' expectations as to the course of future monetary policy, or the consequences of past policy, and have, in many cases, proven useful as predictors of future real growth or inflation. Other asset prices monitored by some central banks include commodity prices, which can be forerunners of inflation, and share prices, which can be related to bond prices, and which may also play a role in the transmission mechanism through wealth effects.

As discussed in Chapter I, derivatives facilitate the separate management of interest rate and currency risk and enhance asset substitutability. This may affect the information that central banks draw from financial market prices. In particular, as a result of the growing use of derivatives to diversify portfolios internationally, they may have contributed to increased foreign investment in domestic money and capital markets. This may have altered the relationship between recorded long-term cross-border capital flows, exchange rates and interest rates, and may have entailed a need to monitor more closely than before exchange rates, short-term interest rates and long-term interest rates as a set.[28]

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[28] For instance, if non-residents buy domestic bonds and hedge their currency risks through derivatives, long-term interest rates would tend to fall (due to foreign purchases) and money market interest rates increase (due to hedging). Such a tilt in the yield curve (while the currency is stable) could be interpreted as reflecting market expectations that the central bank will tighten policy. However, such movements could also take place in the absence of recourse to derivatives, for instance, through the funding of a long bond position via short-term currency borrowing.

Derivatives may have made it more difficult to extract information from price indicators. There is no substantive evidence to suggest that this has been the case in normal times. In times of market stress, to the extent that derivatives may have exacerbated asset price volatility, the value of price indicators for directional readings on the economy could be affected. However, even in such circumstances, price indicators may still convey important information in so far as they reveal major changes in sentiment or liquidity pressures.

3.2 Derivatives markets as providers of new information for market analysis by central banks

3.2.1 Information conveyed by derivatives

Derivatives markets may provide central banks with new opportunities to gauge market sentiment as to the future movements of a variety of asset prices and to evaluate the strength of market expectations. For example, option markets summarise market expectations regarding future price volatility and thus should provide genuinely new information. While other information provided by derivatives markets can also be observed in cash markets, derivatives prices often allow messages to be distilled more easily. Financial market participants increasingly use prices determined in derivatives market to assess directional changes as well as expected volatility in market prices. This, in itself, may be a reason for central banks to monitor such prices.

3.2.1.1 Market views on future asset prices: forward-type markets

Prices in forward-type markets summarise market views on the expected values of a wide range of asset prices (including interest rates, exchange rates, equities and commodities) at various time horizons (in one month, three months, etc.), and can be used to extract expected price paths of underlying assets. While this information can also be derived from cash market instruments (e.g. forward interest rates implied from the yield curve), it is sometimes more easily extracted from the prices of forward instruments. If derivatives markets are more liquid than cash markets, forward prices may be informationally superior to the latter. However, both derivatives and cash market prices may on occasion be subject to overshooting. They may also contain time-variable risk premia which can make it difficult to distil market expectations from them.

3.2.1.2 Implied volatility derived from option markets

With the exception of expected asset price volatility, all other variables needed to price options are either determined in other markets (e.g. short-term interest rates, or forward rates) or are specific to the option in question (e.g. the strike price or the time to maturity). As a result, variations in options prices that are not driven by other observable prices or by the options' specific characteristics are due to variations in the expectations of future asset price volatility. In essence, therefore, an options market is a market for assigning a price to expected volatility. Once the market price of an option is known, a measure of the expected variance of the price of the underlying instrument, known as the implied volatility (IV), can be calculated.[29] A rise in implied volatility may indicate market expectations for larger fluctuations in prices of underlying assets in the future (even if the expected future levels are stable) and/or greater uncertainty over the appropriate future level for those prices. A low and stable IV, on the other hand, reflects market expectations of less volatile prices of the assets and/or greater certainty about the expected means.

The IV provides information concerning the dispersion of market participants' expectations and such information can be used to make inferences about the likelihood and possible size of future price movements. These inferences can be expressed in terms of confidence intervals associated with a range of anticipated prices.

3.2.1.3 Shape of the distribution of expected price changes: call/put price comparisons

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, including those that differ by strike price or those that confer the right to buy (calls) versus the right to sell (puts), can be used to get a more detailed reading on the distribution of market uncertainty. Useful information may be provided by the notions of "risk reversal"[30] (in the foreign exchange market) and "smile curve"[31] (in the bond

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[29] More precisely, given that options models generate options prices as a function of volatility, it is always possible to invert this relationship. Market prices can thus be used to derive the implied volatility of options.

[30] Risk reversal is a transaction which combines a written put and purchased call (or vice versa) on the same currency with the same term, nominal amount and delta value. Risk reversal prices are quoted as the difference in the implied volatility of the call and put options. A rise in the price of puts relative to that of calls could indicate an increase in the relative demand for put protection and thus market expectations of a depreciation of the currency.

and stock markets) which indicate how call and put premiums compare. These are sometimes interpreted as indicating skewness in the distribution of expected asset returns. It is important to distinguish between two factors anticipated by market participants: the relative size of probable upward and downward price movements and the probabilities attached to these movements. The importance of this distinction can be seen by conceiving of a situation where: (i) the probable size of upward movements of underlying asset prices is much larger than that of downward movements; (ii) the probability of upward movements is much smaller than that of downward movements; and (iii) the expected value of future prices is the same as if the probable sizes of movements and the probabilities attached to them were symmetrical. In this case, there would be greater demand for insurance against possible large upward price movements than against possible small downward ones, making call options more expensive than put options. Other possibilities are that transactions costs have not been adequately captured in the options pricing model used or that the market expects volatility to vary over time and this has also not been captured in the pricing model. To the extent that the pricing difference does reflect skewed risk perceptions, this may be seen as an indication of market sentiment that cannot be obtained from the relevant futures prices.

3.2.1.4 Call/put volume ratio

A comparison of the respective turnover of call/put options on an underlying asset may indirectly provide information on market sentiment. In Japan there is empirical evidence to suggest that movements in the Japanese Government Bond (JGB) call/put ratio move with or precede changes in the actual prices of underlying assets. When the ratio begins to rise, prices of underlying assets normally start to rise as well.

The summary indicators discussed in the preceding sections may help central banks to judge the general direction and the diversity of market participants' expectations about future prices of a variety of assets. Moreover, quantity indicators such as movements in turnover and in particular open interest in derivatives markets can be helpful when connected to other sources of information.

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31 The volatility "smile curve" can be drawn by plotting strike prices (out-of-the-money puts, at-the-money-calls or puts, out-of-the-money calls, in this order from left to right) on the horizontal axis and the implied volatility embedded in the prices of these options on the vertical axis. The curve facilitates comparison of put and call prices at the same, and different, strike prices. Its typical U-shape arises from liquidity effects, dynamic hedging risks and anticipations with respect to the direction of underlying asset price movements.

The table below summarises a set of key indicators drawn from derivatives markets and which central banks could monitor in order to assess market sentiment on the direction and volatility of exchange rates and short- and long-term interest rates. Although experience shows that these indicators do not have good predictive power, they do provide insights about changes in market expectations and uncertainty.

Indicators that can be drawn from derivatives market data

	Market views on future asset prices (forward-type derivatives)	**Expected volatility (option-type derivatives)**	**Distribution of expectations of prices changes**
Exchanges rates	Foreign exchange forwards and futures	Implied volatility of currency options	Call/put price ratios: risk reversals Call/put volume ratios
Short-term interest rates	Futures contracts on e.g. 3-month interest rates FRAs on short-term interest rates Interest rate swaps	Implied volatility of options on 3-month interest rates futures contracts Caps, floors	Call/put price ratios: smile curves Call/put volume ratios
Long-term interest rates	FRAs on long-term interest rates Interest rate swaps	Implied volatility of options on government bond contracts Caps, floors, swaptions	Call/put price ratios: smile curves Call/put volume ratios

3.2.2 Factors bearing on the quality of information from derivatives markets

The quality of information obtained from derivatives markets varies for a number of reasons. For some types and terms of products, turnover can be relatively low. In such cases, information from derivatives markets must be complemented with cash market data.[32] Another difficulty with derivatives prices is that actual transactions prices cannot easily be obtained. This is mainly a problem with prices for some over-the-counter products, where screen based information may only be indicative. Moreover, in times of stress, screen-based prices may not be updated. However, it has proved relatively easy to obtain price information on many foreign-exchange OTC derivative products from market makers.

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32 For example, in Japan, turnover in the 3-month Euro-yen futures contract can occasionally be low, with the result that the rates determined in the market do not necessarily reflect overall market expectations. However, most other short-term interest rate futures markets in the principal currencies are very widely traded.

A difficulty with extracting information from derivatives prices is that a pricing model must be posited and solved to obtain the desired information. For example, a mathematical formula must be used to calculate implied volatilities from observed option prices. There is, however, no single option formula which captures all the complexities of options pricing, and the assumptions underlying common models are often violated. For example, the commonly used Black-Scholes model for options pricing assumes that expected asset prices are symmetrically distributed around the mean. As a consequence, implied volatilities calculated from puts and calls should be the same. However, this is not always the case. If models used by central banks differ significantly from the models used by market participants, the estimated implied volatilities would not correctly reflect the views of the market.

3.2.3 Current use of information from derivatives markets for market analysis

A number of central banks utilise information from derivatives markets as part of ongoing monitoring of financial markets, but the type of information used may depend on market conditions. For example, derivatives can help to identify the relative contribution of greater uncertainty and inflation expectations to a sharp rise in bond yields.

The Bank of England watches the long gilt future and short-sterling future (SSF) in its day-to-day analysis of interest rate expectations. The long gilt future also serves as a useful summary statistic of what is happening in the relevant part of the gilt market because it is deliverable by a basket of securities. The Bank of England is currently considering whether the SSF could help in estimating the short end of the sterling par yield curve. Furthermore, it uses futures to identify interest rate expectations in other countries since they are easily read and are sometimes more liquid than cash instruments. The Bank of England has also been following developments in implied volatilities (for currencies and interest rates) more closely.

The Federal Reserve monitors options prices on futures contracts to assess the likelihood of changes in short- and long-term interest rates, spot exchange rates, commodity prices such as crude oil, and stock prices. Prices of futures contracts are used to extract expected paths for interest rates, such as the federal funds rate and three-month spot and futures rates for the G-7 countries. Some of the information taken from derivatives markets is summarised on a regular basis, for example as part of the weekly briefing packet provided to the Governors or as part of the FOMC forecasting cycle.

Other information is used on an occasional or ad hoc basis, such as a special topic in a weekly briefing by the Board's staff to the Governors.

The Bank of Japan uses various indicators from derivatives markets for daily monitoring purposes. For example, Euro-yen futures rates and yen-yen interest rate swap rates are used to calculate yield curves and forward rates. JGB futures prices and stock index futures prices are also important sources of information in the monitoring of market trends. Trends in options on the JGB future and options on JGBs traded over-the-counter, as well as options on stock indices, are monitored to identify price expectations among market participants. Forward transactions and currency options are by far the most popular derivatives transactions in the Tokyo foreign exchange market. The Bank of Japan monitors these transactions with a view to increasing the effectiveness of interventions in the foreign exchange spot market.

The Banque de France uses various indicators from derivatives markets to monitor the direction and dispersion of expectations regarding interest rates and exchange rates. For instance, prices of short-term futures contracts are used to assess market participants' expectations of the evolution of short-term interest rates in several countries. The Banque de France also monitors the evolution of the implied volatility of exchange rate (USD/DEM, DEM/FRF) and interest rate (Notionnel, Bund and US Treasury bonds) contracts. Notably, the prices of options on the Notionnel contract are used to assess market expectations about future long-term interest rates.

The Bank of Italy regularly monitors the evolution of a number of derivative products in order to monitor market views on expected future interest and exchange rates and risk premia. Among them are interest rate swaps on major currencies, futures on three-month euro-deposits, futures and options on government bonds and on foreign currencies.

The Deutsche Bundesbank monitors forward rate agreements on interest rates to assess short-term interest rate expectations. In addition, research activities have been devoted to make use of option prices on the Bund future, as well as futures and options prices in the foreign exchange markets.

IV. Implications of derivatives markets for the instruments of central banks

This chapter is divided into two sections. The first analyses the implications of the growth of derivatives for the effectiveness of traditional monetary policy instruments in achieving operational targets and the strategies that are relevant for the markets in which central banks operate. The second section considers the potential operational use by central banks of derivatives.

4.1 Implications for traditional monetary policy instruments

Monetary and exchange rate policy, aimed at affecting the levels of interest rates and exchange rates, is mainly implemented through interventions in the money and foreign exchange markets. Given the close links between interventions in these markets in countries that participate in exchange rate agreements, the section also considers the implications of derivatives markets for the defence of a fixed exchange rate target.

4.1.1 Money market interventions

Monetary policy controls the rate of inflation by controlling the growth of money and credit over the long term. In theory, this can be achieved either by targeting the rate of expansion of the monetary base or by targeting the level of short-term interest rates (the price of substitutes to base money). In practice, nearly all central banks target or otherwise orient their policies around short-term interest rates.

Some countries establish a corridor for short-term interest rates, within which interest rates can be influenced by central bank open market operations, and within which current market rates are set. The corridor is typically formed by two facilities: one establishes the upper bound by making available an unlimited quantity of funds at a penal interest rate; the other establishes the lower bound by offering a limited quantity of funds at a below market interest rate. The use of a corridor does not fundamentally change the fact that monetary policy is exercised by controlling the price of central bank reserves.

The price of central bank reserves or settlement balances is determined by the prevailing levels of supply and demand. Because the central bank is the monopoly supplier of central bank reserves, targeting a given level of short-term interest rates

means that the central bank supplies whatever amount of central bank reserves is demanded at that interest rate. The central bank's position as monopoly supplier of central bank reserves is unaffected by the growth of derivatives.

By contrast, derivatives may affect commercial banks' demand schedule for central bank reserves. This may follow from a possible reduction in the demand for cash balances by the general public, or, where relevant, from changes in the balance-sheet determinants of reserve requirements as banks are able to substitute derivative transactions for on-balance-sheet transactions. (For example, a bank might substitute a forward rate agreement (FRA) for a deposit and loan combination giving the same interest rate exposure.) Derivatives may also alter the banks' precautionary demand for central bank reserves by, for example, altering the timing and/or volume of payment flows relative to what would have happened in the absence of derivatives. For example, a pension fund might choose to hedge an equity position by using stock index options rather than by selling equities. If the provider of the options covers the position through dynamic hedging this will substitute many small transactions (and associated payments flows) spread over a period of time for one large payment. One can also envisage situations where the use of derivatives would reduce the volume of payments flows.

One cannot predict how balance sheets or payment flows will change as a consequence of the growth of derivatives markets, but one can be confident that commercial banks will always have a non-zero demand for central bank reserves. At the very least, the demand for cash or other payment services by non-banks and/or reserve requirements will ensure this. Derivatives cannot therefore reduce the ability of central banks to meet particular operational interest rate targets.[33]

Derivatives may, however, influence the relationship between short-term interest rates and the rest of the yield curve. By enabling agents to react more rapidly at particular maturities, derivatives may make the yield curve more responsive to central bank signals. This is probably most significant for the interest rate channel in the transmission mechanism (see Chapter II), but it may also improve a central bank's

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33 The situation may be different under monetary base control where the central bank targets the rate of growth of base money over a given period. This is because the growth in derivatives markets may change the demand schedule for base money. To the extent that the resulting demand schedule is more volatile, a given money base growth target may be associated with greater volatility in short-term interest rates. However, there is no a priori reason to expect the demand schedule to be any less stable than that experienced hitherto.

ability, subject to its credibility, to target particular interest rates at the short end of the yield curve.

4.1.2 Foreign exchange interventions

Sterilised intervention in the foreign exchange markets has, by definition, no impact on the supply of central bank reserves and should not therefore directly affect the level of short-term interest rates. However, there are two main indirect channels through which sterilised interventions can have effects. First, they change the composition of the outstanding portfolio of assets. If the central bank sells foreign currency, it reduces the amount of domestic relative to foreign currency assets that private investors must absorb in their portfolios. To the extent that foreign and domestic assets are perceived as imperfect substitutes, this will lower domestic interest rates and/or appreciate the currency.[34] Second, sterilised interventions may have signalling effects in that such actions may reveal the central bank's preference concerning the levels of exchange rates or interest rates. If the central bank is expected to follow up with a change in monetary policy or has good record in reading the fundamentals correctly, investors will adjust asset prices in the desired direction on the basis of the signal alone. This applies whether the currency is in a floating exchange rate regime or a fixed regime. In the former case the authorities may intervene if, for example, they perceive the exchange rate to have overshot the fundamentals. Similarly in a fixed rate regime, the authorities can be expected to intervene to defend a given target band when they believe the band is consistent with the fundamentals.

By increasing asset substitutability, derivatives may tend to reduce the portfolio effects of sterilised intervention. They are also one factor contributing to increased international capital mobility (see chapter I) and hence to the potential size of short-term flows into and out of particular currencies. Official interventions that are not viewed as being in line with fundamentals, and therefore not credible, may be overwhelmed by the scale of private sector flows in the other direction. On the other hand, greater capital mobility can reinforce the effectiveness of intervention to the extent that markets believe the authorities' signals.

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[34] A decline in the proportion of domestic assets that investors must absorb in their portfolios reduces the risk premium attached to domestic assets. This would cause the level of domestic interest rates to fall in relation to foreign rates, and/or the domestic currency to appreciate instantaneously to provide for greater expected depreciation.

4.1.3 Implications of option markets for the defence of an exchange rate target

The development of derivatives - options in particular - may have affected the defence of an exchange rate target by creating hedging-related positions which may initially slow down the outbreak of crises, but which may intensify them once they begin to materialise. In particular, hedging overhangs may have made it more difficult to anticipate the intensity of pressures in a crisis situation.

These effects result, in part, from the technical characteristics of derivatives hedging. In the case of forward operations, the commitment to exchange the currencies underlying the contracts means that the intermediary typically will immediately cover the total amount of the transaction. For example, if speculators or hedgers purchase foreign currency in the forward market, this decision will entail an equivalent spot sale of the national currency by intermediaries. The effect on the exchange rate will be immediate.

This is not the case for options which will only be exercised if they are "in the money". Options writers have two ways of hedging their positions: (i) purchasing offsetting options or (ii) by establishing cash or forward positions in the underlying currencies. The latter technique, which involves dynamic hedging, could potentially have the most disruptive impact on the foreign exchange market.

If speculators or hedgers purchase foreign currency options for a notional amount and strike price identical to that of a forward contract, the immediate hedging conducted by the seller of the options will imply a lower volume of cash purchases. As a result, the impact on the exchange rate will initially be small compared with a forward cover. This could cause monetary authorities to underestimate initially the scope of latent selling pressures. However, if the currency were to weaken and the options overhang was large, selling pressures could strengthen because of the deferred hedging needs of options writers.

In short, the widespread use of options could modify the timing of selling pressure on a currency and slow down the outbreak of an exchange rate crisis, but could also intensify the crisis once it has developed. The potential significance of this problem depends on the extent to which options are used. So far, options transactions, although growing rapidly, account for a small share of total foreign exchange transactions and are therefore unlikely to significantly affect the ability of central banks to defend an exchange rate target.

4.2 Potential operational use of derivatives by central banks

The growth of derivatives markets has widened the array of instruments that central banks have at their disposal to achieve their monetary policy goals. This section reviews the potential operational use of derivatives by central banks to influence short-term interest rates, or the exchange rate associated with a given level of interest rates. The section also reviews arguments relating to their use for purposes of stabilising markets, and considers the implications of derivatives market intervention for the informational content of market prices.

4.2.1 Potential operational use of interest rate derivatives[35]

For purposes of controlling short-term interest rates, central banks have traditionally intervened in the short-term money market. These operations work mainly by directly affecting overnight or very short-term liquidity conditions in the money markets. Intervention with derivatives, given their small cash requirements, would not materially affect liquidity conditions and could not, therefore, be a substitute for current cash market operations.

The direct influence of traditional monetary operations on maturities exceeding one month is generally diffuse, depending not only on the current stance of monetary policy but also on the expected future course of monetary policy and on expected economic growth. This raises the question of whether money market-type derivatives such as FRAs, futures or options could be used to influence a broader range of money market rates more directly. This might be considered if the derivative market is larger and more liquid than the interbank market at the corresponding maturity. Consideration might also be given to influencing the risk premium in short rates directly through operations in the options markets, although there would need to be a way of ensuring that such operations were consistent with the chosen level for the short rate typically under the central bank's direct control.

The influence on money market rates that could be achieved through the use of derivatives should, however, be carefully balanced against risks to monetary control and

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[35] The use of interest rate derivatives in the conduct of monetary policy has received less attention and raises broader questions than the use of derivatives in foreign exchange market intervention. This section provides only tentative arguments; a more considered treatment is required given differences among countries in operating procedures and in domestic money and derivatives market characteristics.

of loss of information. Attempts by central banks to target medium and long-term interest rates could be expensive and, because of the substantive impact on the central bank's balance sheet, detrimental to monetary control, unless offset by other operations. Although the leverage provided by derivatives could lessen such concerns, the targeting of a medium-term rate through derivatives may create expectations in the market that the central bank would also stand ready to intervene in the corresponding medium-term cash market. Another important consideration arises from the possibility that intervention at longer maturities will be interpreted by market participants as reflecting the central bank's views on the future course of the economy. This, along with the direct impact of the intervention, could affect the shape of the yield curve and the information contained therein. A desire to preserve this information content would argue against such interventions.

4.2.2 Potential operational use of foreign exchange derivatives

4.2.2.1 Forward market interventions

An intervention in the forward market is economically equivalent to a spot market intervention that is sterilised through an offsetting transaction changing the central bank's holdings of domestic currency assets. Consider a forward sale of foreign currency and assume that the buyer is a domestic bank. The bank will have sold domestic currency for future delivery. To cover its exposure, it will buy domestic currency spot and invest it in an interbank deposit with the same maturity as the forward contract. It is easy to see that the bank's position would be the same if the central bank had sold foreign currency spot and sterilised the effect on the monetary base by making a deposit with the commercial bank. However, because forward market intervention does not affect foreign exchange reserves, there will be no immediate effect on the central bank's balance sheet.

Another aspect that may be relevant for the choice of which instrument to use is that forwards, by providing automatic sterilisation of the intervention, allow the central bank to circumvent technical difficulties that could be encountered in that process, e.g. limitations in the domestic money market. In this regard, forward intervention may be considered more efficient in cases where the central bank wants the intervention to be fully sterilised.

As noted above, a forward sale of foreign currency is equivalent to short-term borrowing of foreign currency by the central bank. This is especially interesting in a fixed exchange rate regime, as forward market interventions enable the central bank to

extend its support of the domestic currency beyond the current level of foreign exchange reserves. This can be seen from two different perspectives. On the one hand, it improves the central bank's ability to withstand speculative pressures against the domestic currency and may therefore also reduce the likelihood of a speculative attack.[36] Forward market intervention can also be useful to the extent that it allows the central bank to buy time. On the other hand, such intervention could place the central bank at the risk of larger losses if the support for the domestic currency proved to be ineffective.

It should be noted that there are alternatives to forward intervention as a means of extending support for a currency (e.g. borrowing in foreign currency). It is therefore unlikely that the possibility of using forward market intervention will materially affect the central bank's ability to assume foreign exchange rate risk.

4.2.2.2 Option market interventions

Options have asymmetric payoffs and their values have a non-linear relation to the price of the underlying asset. They are therefore more complicated than instruments that central banks normally use. However, much of what has been said above also applies to options. In particular, options market intervention may affect market prices through both the portfolio and the signalling channels. For example, by writing put options on the domestic currency (provided that this is done without delta hedging), the central bank reduces private agents' open positions in the domestic currency. This demonstrates its willingness to assume the risks of depreciation and signals a determination to defend the current exchange rate level.

The differences in the payoff structures between forwards and options mean that the risk distribution will be affected by the choice of instrument. For example, by writing put options on the domestic currency, the central bank insures the private sector against the risk of loss in the event the currency depreciates. This would deflect hedging or selling pressures that would otherwise materialise in spot or forward markets. Sales of options by the central bank could also reduce implied volatility. This could be desired for its signalling effect, or to counter disorder in the foreign exchange

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[36] To affect the likelihood of an attack, it is important that the central bank is also perceived to be willing and able to defend its exchange rate peg with a change in monetary policy, i.e. by raising short-term interest rates, should this prove necessary. This follows from the general proposition that signals must be expected to be followed by concrete actions to have the desired effects.

market, although further examination would be required to assess the influence of reduced implied volatility on the delta hedging of existing options positions.

Options and forwards differ in their practical usefulness. For example, forward markets are typically deep and easy to price on the basis of the arbitrage relation between the forward premium and the interest rate differential. In contrast, although they have developed rapidly in recent years, options markets other than for the major currencies are often thin.

It may be difficult to determine a priori whether options are an effective new instrument for sterilised intervention or whether forwards are preferable to options. Qualitatively, intervention through options and forwards can be expected to have similar effects on the levels of interest rates and exchange rates, although intervention through options could have an additional influence on expected volatility. Nevertheless, the quantitative effectiveness of such intervention is still open to question, given the general notion that sterilised intervention has short-lived effect unless followed by policy action.

4.2.2.3 Assessment

While forward markets do not provide central banks with any unique instruments as, in general, combinations of conventional spot market interventions can be used to obtain the same effects, options provide central banks with an instrument to intervene which can affect not only the spot market's trend, but also expected volatility as embedded in options prices. Interventions in both kinds of derivatives markets may allow immediate sterilisation and make it possible for the central bank to modify the signal that its sterilised interventions send to the markets. In addition, forward and option interventions can be used to extend the support of the domestic currency beyond the current level of reserves and also to strengthen the commitment to an exchange rate target zone.

On the other hand, relying on derivatives for intervention purposes can also have important drawbacks. First, there is the risk that, in situations when they are most needed, derivatives markets will not be sufficiently deep and well-functioning, severing the arbitrage links to the spot markets. Second, some options markets have so few market makers that central bank intervention may induce them to take interventions into account in their own pricing and positioning decisions (thus introducing "moral hazard" risks). However, such considerations may apply equally to spot or forward market intervention. Third, in some cases, the use of derivatives to extend the scope of

intervention might be perceived as a way of postponing difficult decisions about the policies that have a bearing on the fundamental determinants of the exchange rate.

Overall, the balance of these advantages and drawbacks is likely to depend on the structure of the relevant financial markets, the operational procedures of individual central banks, and the circumstances at hand.

4.2.3 Potential use of derivatives to stabilise markets

Central banks may wish to intervene to stabilise markets or prices in certain circumstances. They are unlikely to contemplate such intervention in markets other than those through which policy is implemented. For example, if prices considered to be of particular interest to central banks - such as foreign exchange rates or short-term interest rates - exhibit high volatility and overshooting in both directions during relatively short periods of time, this may be considered undesirable. The principles regarding intervention in these volatile markets are not fundamentally different from the situation described in the previous section. The only exception, at least in theory, may be that options provide the possibility of aiming the intervention at implied volatility. By selling put and call options at the same time, implied volatility will decrease, without pushing the market in a certain direction (provided, of course, that the net impact of delta hedging is neutral). Another situation that might call for stabilising intervention is when a temporary liquidity shortfall leads to large price movements unrelated to underlying fundamentals. Such price movements may involve unnecessary costs to the economy. For instance, temporarily thin markets can create volatile conditions and relatively large price swings.

Although circumstances could arise in which the use of derivatives might be more efficient, there is no reason to believe that the interventions required to stabilise markets in the above circumstances, which would typically involve very small amounts, could not be carried out with the use of traditional cash instruments. More generally, interventions to stabilise markets are complicated by the difficulty of distinguishing temporary deviations from prices motivated by "fundamentals" from persistent shifts in market perceptions.

4.2.4 Potential loss of information content of derivatives prices due to central bank interventions

Some concern has been expressed that intervention by central banks in derivatives markets could potentially reduce the expectational information in financial market prices. Any intervention or monetary policy action will, to a greater or lesser extent, influence spot prices, expectations regarding future prices and market conditions more generally (volatility, liquidity). The effects of these interventions will be felt in both cash and derivatives markets.

It is not clear that this is undesirable. For instance, the sale of currency put options by central banks may lead to a decline in implied volatility. Similarly, a spot market intervention that indicates that the central bank is concerned about the behaviour of the price in question could, albeit indirectly, affect the market assessment of the expected future volatility. This could be reflected in a reduction of implied volatility in option markets.

In general, therefore, central banks cannot expect to find "pure" information variables in foreign exchange or interest rate markets. However, it can still be argued that a useful distinction could be drawn between the markets in which the central bank intervenes directly, and markets which reflect the actions of the central bank taken elsewhere. For example, by intervening directly through interest rate options, information on how the market perceives the variability of monetary policy set through the level of short-term rates would be lost.

V. Conclusion

Although highly prominent, derivatives are only part of the process of financial innovation that has been gathering speed over the past twenty years. It is therefore not surprising that many of the implications of the growth in derivatives markets for the economy and monetary policy are similar to those of other factors involved in the same process, and that they are difficult to isolate.

As with other features of financial innovation, the growing use of derivatives should help promote more efficient resource allocation and strengthen the economy's resilience to shocks.

The limited evidence available suggests that developments in derivatives markets are unlikely to have altered significantly the transmission channels of monetary policy or the efficacy of traditional monetary instruments. Although derivatives may alter the information content of the monetary and credit indicators currently used by central banks, it is not yet clear that this impact has been quantitatively significant. Moreover, derivatives may provide central banks with additional information to guide their monetary policies, as well as additional tools for implementing them.

Derivatives are much more a consequence than a cause of instability in exchange and interest rates, although in times of stress they may contribute temporarily to increased asset price volatility. Consequently, in a derivatives-influenced environment, central banks will need to take greater care to ensure that their policies do not contribute to uncertainty, but rather facilitate the formation of stable non-inflationary expectations. This is most effectively accomplished by a clear and continuing commitment to price stability.

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