

MEASUREMENT OF BANKS'

EXPOSURE TO

INTEREST RATE RISK

Consultative proposal by the

Basle Committee on Banking Supervision

Basle

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MEASUREMENT OF BANKS' EXPOSURE  
TO INTEREST RATE RISK:  
A PROPOSED MEASUREMENT FRAMEWORK

INTRODUCTION

1. The purpose of the attached paper is to report on the work by the Basle Committee to measure the interest rate risk run by internationally-active banks. It sets out a number of issues relating to the analysis of the risk and indicates the proposals that are being considered to address them. On several issues the Committee has not yet come to a conclusion and the pros and cons of different alternatives are set out for the industry's consideration. The questions on which comment is specifically invited are put forward in Section V.

2. All members of the Basle Committee regard interest rate risk as a significant risk which banks and their supervisors need to monitor carefully. They believe that there would be merit in pursuing a common approach to measuring this risk, even though differences in banking product, customer behaviour and regulatory approach would necessitate a degree of national discretion.

3. The measurement of interest rate risk would follow a fairly straightforward approach. Banks would categorise interest rate sensitive assets, liabilities, and off-balance-sheet instruments according to their maturities or certain repricing characteristics. This paper sets out a number of proposed methods for "slotting" various instruments into their maturity bands. In the main proposal, duration-based weights are applied to the on- and off-balance-sheet positions in the different maturity bands (duration being a measure of price sensitivity for unit changes in interest rates).

4. The next step is to compute the difference between the duration-weighted assets and liabilities, subject to certain adjustments. The resulting number is an estimate of the change in the value of a bank as a result of a specified change in interest rates. This number for a bank with long-lived (high duration) assets relative to short-lived liabilities provides an indicator of the degree to which the bank's value would be adversely affected by, say, a rise in interest rates. Such a bank would find that its value, if sold as a going concern, would be less than it was

before the rise in rates. This paper also points out that a similar exercise could be used to determine the likely reaction of earnings to changes in interest rates.

5. Recognising that a fair amount of interest rate mismatching is a normal feature of the business of banking, the Committee holds the view that existing capital requirements can be regarded as covering a certain amount of interest rate risk. The purpose of the framework is to develop an approach to measuring how much risk banks are taking as a basis for then identifying those taking a considerable amount of interest rate risk, the so-called "outliers". Just what constitutes an outlier must be interpreted against a norm, a process involving substantial supervisory judgement. The supervisory response to outliers would, for now, be left to national discretion. For example, supervisors could take action through the examination process, by imposing absolute limits on positions, by applying capital requirements, or by some combination of these approaches.

6. Information derived from gap reports can be analysed from different perspectives. The methodology described above is designed to estimate the sensitivity of the economic value of the bank to future changes in interest rates. However, accounting differences suggest the need to consider other aspects of interest rate risk, for example the sensitivity of reported earnings to future changes in interest rates. It is also important to monitor the embedded losses caused by past movements in interest rates but not yet recognised in accounts that are carried at historic cost.

7. As described in the early part of the paper, the Basle Committee is concurrently issuing proposals for applying capital requirements for market risk to debt securities in the trading portfolio. It is the view of the Committee that, in seeking to measure interest rate risk for the purpose of identifying outliers, it is reasonable to take account of the risk over the whole bank, including those trading positions on which capital would have been levied. However, it is by no means clear that integrating the trading and non-trading books to the extent of allowing full offsetting between opposite positions in the two books is always appropriate. Ideas on whether and if so how the trading book should be integrated with the remainder of the book for the purpose of identifying "outliers" would be valuable.

8. Comment is invited on all aspects of this paper, including the measurement principles envisaged, by end-December 1993. Specific questions on a number of unresolved issues are set out in Section V. It is recognised that, at least for major banks, the system envisaged is relatively simple and would not be intended to supplant other more precise methods of determining interest rate risk that banks may currently be using. However, before implementing any common system on an international scale, the Committee would again wish to canvass opinion from the industry on the suitability of the approach ultimately chosen.

MEASUREMENT OF BANKS' EXPOSURE

TO INTEREST RATE RISK:

A PROPOSED MEASUREMENT FRAMEWORK

I. BACKGROUND

1. In July 1988 the Basle Committee concluded an agreement establishing risk-based minimum capital standards for internationally active banks. The Basle Accord, as that agreement has come to be known, entered into full effect at end-1992 and has been adopted in all the major financial centres, both in and outside the G-10. However, it focuses primarily on credit risk, i.e. the risk of a deterioration in the ability of a borrower or other counterparty to meet its obligations. It does not impose explicit capital charges tied to other banking risks, such as those related to changes in market interest rates (interest rate risk), or to changes in foreign exchange rates. Nonetheless, the Accord stated that the Committee would continue to study these risks and, where appropriate, would incorporate them in the risk-based framework.

2. Following adoption of the Accord, representatives from Committee member countries have been working to develop ways of assessing a bank's overall exposure to changing interest rates and to a variety of other so-called "market risks". In addressing market risks, a number of factors dictated that the Committee direct much of its efforts toward convergence between the capital standards of securities firms and the trading activities of commercial banks. These factors include the continuing integration of world financial markets, the growing securitisation of financial instruments, and the harmonisation process within the European Community. Proposals for applying capital requirements to positions in traded equities and debt securities are contained in the present package.

3. The market risk proposals relate to trading activities valued at current market prices and do not address interest rate risk arising from the more traditional activities of banks, which is the focus of the present paper. These other activities, primarily lending and deposit taking, raise different and difficult issues regarding the measurement of interest rate risk of banks because of the uncertain maturities and uncertain sensitivity to market rates of many of their assets and liabilities.

4. Interest rate risk is the risk that changes in market interest rates might adversely affect a bank's financial condition. Banks are

exposed to interest rate risk whenever the interest sensitivity of their assets does not match the sensitivity of their liabilities or off-balance-sheet positions. For a bank whose liabilities reprice faster than its assets, a rise in interest rates can reduce net interest income by increasing the institution's cost of funds relative to its yield on assets, and vice versa.

5. Changes in interest rates may affect not only an institution's current earnings but also its future earnings and the economic value of its capital, reflecting changes in the value of the institution's financial instruments. For the bank with liabilities carrying interest rates which change faster than those on its assets, its net present value will decline if interest rates rise. Measuring that risk is the main focus of this paper.

6. As with other risks, there are two separate stages in determining the appropriate supervisory approach. The first is to decide how to measure the risk. The second is to decide what action, if any, supervisors should take to discourage excessive risk-taking. Such action could, for example, be limits, capital requirements or discretionary supervisory measures. Given the number of outstanding issues which arise in measuring interest rate risk, the Committee is not proposing a common international capital standard for interest rate risk. Rather, its efforts are being focused on the development of a measurement system which supervisors could use for observation purposes as a means of identifying "outliers",<sup>1</sup> leaving each authority free to decide how to respond in the case of institutions identified as high risk. Individual supervisors may, of course, decide that capital requirements would be appropriate to their own national circumstances. However, a range of other possible responses could also be envisaged.

7. So far as the measurement framework is concerned, the Committee has developed proposals for addressing many of the issues. The recent work with securities regulators has been useful in enhancing understanding of price risk. However, the nature and analysis of interest rate risk in the banking book differs, in some respects, from that in the trading book. In

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1 This is the approach the US authorities have taken in recent proposals to incorporate interest rate risk into the risk-based capital framework.

addition, the degree of detail and accuracy required in order to set capital requirements for the trading book is greater than is necessary or possible for what is intended to be principally an observation framework for the banking book.

8. In measuring interest rate risk, there are a number of complex issues which could well merit different solutions depending on the purpose of the analysis and on particular national circumstances.

9. There is, for example, no consensus about the extent to which offsetting should be allowed between the interest rate risk arising from different positions or types of business in the banking book, and between banking and trading activities. But the principal difficulties are associated with the treatment of items common to banking whose actual maturities may be uncertain, or can differ from their contractual terms. Examples include pre-payable mortgages or hire purchase (instalment) loans and instruments such as savings deposits and demand deposits on which the interest rate paid tends to be less responsive to changes in market interest rates and which allow individual banks some discretion in the timing and extent of changes to the rates they pay. The way in which these items are treated is crucial to the measurement of interest rate risk. However, extensive discussion has not revealed a consensus on a standard approach or common set of assumptions which could be applied across all classes of instrument and across all countries.

10. Despite these difficulties, the Committee would like to introduce some form of interest rate risk measure on a regular and consistent basis. The Committee also feels that experience in collecting and analysing such information from their banks, and discussing its implications with them as part of the ongoing supervisory process, will help to reveal the practical effect of the analytical problems more fully. That process, in turn, could facilitate the development of a consensus and lead to further refinement of the measurement system. It is recognised that there will be costs to banks in this process and care is needed to ensure that the value of the information sought is sufficient to justify these costs.

11. As a first step, the Committee is seeking to develop a consensus on a common reporting framework which would allow national supervisory authorities to collect consistent information and from which various measures of interest rate risk could be considered and ultimately constructed. An outline of the type of framework which would be needed is

described in Section IV. Initially at least, discretion would be given to supervisors in the way in which they analyse and interpret the information they would receive. But, recognising the costs involved to banks in changes to reporting systems, the framework is designed to facilitate changes to the measurement of risk as a consensus emerges as to which measure or measures are to be preferred.

## II. MEASUREMENT CONCEPTS

12. Banks are potentially exposed to interest rate risk on all their interest-rate related assets and liabilities, whether they are held for trading and are marked to market or are held for a longer time horizon and carried at nominal or book value. When interest rates change, the price of items that are marked to market will change to bring yields into line. However, the economic value<sup>2</sup> of the assets and liabilities held at book value will also change in the same way, although the effect on the reported balance sheet will be much more gradual, since it will be spread over the remaining life of the assets and liabilities.

13. The extent to which the economic value of a bank is exposed to changes in interest rates depends upon the extent to which it is running mismatches. If a bank is funding five-year fixed rate loans with short-term deposits, it is exposed to changes in interest rates. But if it funds these loans with deposits having the same maturity and cash-flow characteristics, it is not exposed, since any change in the economic value of the loans would be offset by a change in the economic value of the deposits. Banks often do not match their loans and deposits directly in this way because they can take a variety of other steps to hedge their interest rate risk.

14. While accepting that there could be different focuses for the measurement system (see paragraphs 19 to 24), the Committee has concluded that the principal objective should be to assess the extent to which the economic value of a bank is exposed to future changes in interest rates, using the following processes:

- all interest-rate sensitive asset, liability and off-balance-sheet positions would be placed into one of thirteen time-bands based on the instrument's maturity or repricing characteristics. The positions within each time-band would be

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2 The term "economic value" used in this paper refers to the going-concern value of the bank. The objective is to capture the change in an institution's net economic value attributable to interest rate risk. This change would be computed as the change in the present value of the institution's assets minus the change in the present value of its liabilities plus the net change in the present value of its off-balance-sheet positions for an assumed change in market interest rates.

netted and the resulting net position for each time-band would then be weighted by an estimate of its duration<sup>3</sup> (see Annex 1);

- the duration weights would be adjusted to reflect the relative volatility of interest rates across the term structure;
- the net balance of these individual weighted positions would form the principal basis for evaluating an institution's interest rate risk;
- it may be appropriate to add to this measure "disallowance factors" to full offsetting referred to in paragraphs 43 to 48.

15. Applying this methodology to all assets and liabilities, irrespective of whether they are marked to market or held at book value, raises, however, several problems.

16. Some imprecision will be introduced into the measure of exposure to future changes in rates because the duration weights would be applied in many cases to book values rather than to market values. But it is not evident that this imprecision will be significant: in aggregate, book values may generally be a reasonable approximation to market values for these purposes - particularly if current interest rates are close to the average rates paid and received on banking book positions.

17. Another difficult question is the extent to which interest rate risk should be viewed on a whole book basis or whether the trading book, which is marked to market, and the banking book, which is often not, should be treated separately. It is clear that from an economic perspective the effect of a change in interest rates on any given financial instrument is the same, regardless of whether the instrument is held in a trading portfolio or in a banking book. A case could be made that banks which manage the interest rate risk of their banking and trading books in a fully integrated manner should be allowed to offset positions for risk management purposes.

18. There are, nonetheless, practical effects which may justify separate treatment of the trading and the banking books for the purpose of measuring interest rate risk. If a bank has an exposure in a trading book asset that is offset by a banking book liability and rates change, creating

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3 Duration is a mathematical concept designed to measure the price sensitivity of fixed-rate instruments with different maturities to changes in interest rates.

a market value loss in the trading book and an (economic value) gain in the banking book, the bank will take an immediate hit on its profits and capital but may not be able to realise the gain in the banking book at the same time. Furthermore, unlike the banking book, the composition of the trading portfolio often changes significantly from week to week or even day to day. This means that a hedge that is present on the reporting date may disappear a few days later. In such cases, complete offsetting may not be justified. Of course, the issue of separating the trading and banking books has to be evaluated in the context of the market risk proposal for traded debt. Under this proposal, the trading book becomes subject to explicit capital charges.

19. The existence of different accounting rules for different categories of assets and liabilities suggests the need to consider measuring two other aspects of interest rate risk. One is the sensitivity of a bank's earnings (profit and loss) over the short-term to a given change in rates, the so-called current earnings perspective. The other is the possibility of embedded losses, for example where banks have in the past made loans at fixed or inflexible rates which now fall short of current funding costs.

20. Under the current earnings perspective, the main focus is the sensitivity of the profit and loss account in the short term (e.g. one year) against a given change in interest rates (say 1%). The objective is to identify those banks which are especially vulnerable to fluctuations in recorded profits, irrespective of whether any losses incurred may be offset, under the economic approach, by larger earnings which, because of accounting conventions, will only emerge gradually over the years.

21. The current earnings approach differs from the economic perspective in two main ways. The first difference is that the effect of interest rate changes is measured in terms of reported profits rather than economic value. This difference may be quite important where marking to market is not predominant. Secondly, the time horizon is shorter since in this case the supervisor is not trying to estimate the capacity of banks to withstand the long-term impact of movements in interest rates. Nonetheless, the supervisor would still wish to look at the whole maturity profile of the bank in seeking to identify outliers.

22. In order to apply the current earnings measure, in terms of the parameters referred to in paragraph 20 above:

- all the positions would be placed in the maturity ladder as described in Section IV. Since this approach does not evaluate the economic effect of interest rate movements, no duration-based weighting factors would be applied;
- the supervisor would focus on the shorter time-bands up to one year;
- gaps in the four shortest time-bands would be calculated. To evaluate the sensitivity of net interest income implied by these gaps, the net position within each time-band would be multiplied by an assumed interest rate change and by the length of time, for the period being evaluated, that the gap would be in effect;<sup>4</sup>
- since the focus is on the shortest time-bands, full offsetting, at this stage, is envisaged;
- for the trading book the duration-based framework provides a measure of the impact of a change in interest rates on the profit and loss of the bank. The current earnings approach complements this by giving an estimate of the effect on the profit and loss of changes in interest rates on the rest of the book.

23. A further dimension of interest rate risk which needs to be addressed is the extent of any embedded losses. Assets and liabilities which are not marked to market<sup>5</sup> may already contain locked-in losses caused by past movements in interest rates which will not - because of normal accounting conventions - be reflected immediately either in adjustments to balance sheet values or in provisions. These would only have an impact on the accounts over the life of the assets and liabilities. For example, long-term fixed rate lending entered into when interest rates were low and refunded more recently with liabilities bearing a higher interest rate will, over the remaining life on the loans, represent a drain on the bank's

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4 For example, if a bank had a positive (long) net position of ten million in the first (0 to 1 month) time-band, the annualised net interest income exposure from this net position from a 1% change in interest rates would be: 10 million x 1% x 11.5/12 or approximately 95,833. This assumes that all repricings within the time-band occur at the mid-point of the time-band.

5 For trading positions or for other assets and liabilities which are marked to market, this problem would not arise since all losses arising from an adverse interest rate movement would have been immediately reflected in the profit and loss account.

resources; but the full extent of this loss will not be apparent in the current balance sheet, nor in any one year's net interest income. This is, strictly speaking, an exposure to past movements in rates which is not fully reflected in the balance sheet, rather than to possible future movements in rates.

24. To measure the extent of embedded losses in a systematic manner is a significant task since it would be necessary to take account of the average return (i.e. the interest rate or coupon) of both assets and liabilities in the period to repricing. It is not envisaged that the basic measurement system should seek to do this. Nonetheless, the Basle Committee considers it essential that banks be aware of the approximate size of their embedded losses and that supervisors take the extent of such losses into account in their overall assessment of interest rate risk. Banks could, for example, monitor their embedded losses by estimating the net present value of their banking books. Alternatively, they could track weighted average yields on the assets and liabilities in each time-band. Another approach would be to maintain information on the volume of fixed-rate assets at less than current market rates and their financing.

### III. MEASUREMENT ISSUES

25. In using a basic duration gap analysis to measure interest rate risk, several sets of issues arise in seeking to arrive at a single measure of risk.<sup>6</sup> The first of these concerns the manner in which certain items with special characteristics are to be slotted into the maturity ladder. The second covers the actual weighting to be applied and the extent to which offsetting should be permitted between long and short positions.

26. It is proposed that different maturity ladders should be constructed for each currency in which the bank has significant positions. In principle, banks would be expected either to present a comprehensive reporting return covering the positions in all their major branches and subsidiaries or to be in a position to provide information for all units that are subject to consolidated supervision (see paragraphs 53 and 54). This raises a third set of issues, namely the degree of integration between positions in different currencies and in different affiliates.

#### A. Slotting items into the appropriate maturity bands

##### (a) Amortising items

27. Because they repay principal on a periodic basis rather than at maturity, amortising items merit special treatment. Two approaches could be adopted: they could either be reported separately and then become subject to lower duration weights based on an assessment of the typical amortisation profile of the items concerned; or - more accurately - they could be broken down into their individual tranches and be included in the maturity ladder together with non-amortising items, on the basis of the relevant amortisation dates. Thus a fixed rate loan of 100, repayable in two equal annual instalments, could either be subject to a lower duration weight or included in the standard maturity ladder as two separate loans of 50, one of one year maturity, the other of two years' maturity. Market comment on the practicability of the latter approach would be particularly welcome.

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<sup>6</sup> Most of these issues would also apply if a current earnings approach is used.

(b) Uncertain reset date

28. Using a maturity ladder approach presumes that the final maturity date (for fixed rate items) or next interest reset date (for variable rate items) is a known quantity. This is not true of much banking business. Banks will have assets and liabilities where the final maturity is fixed but the interest re-set date is not, because the rates are linked to an underlying reference rate, e.g. a prime or base rate.

29. It is envisaged that those items where the interest rate adjusts to changes in market rates but the precise reset date is uncertain could be placed in either of the first two bands according to the estimated average lag between the change in their interest rates and the change in market rates. Long and short positions with the same reference rate could be netted.

(c) Uncertain maturity

30. For many items in the balance sheets of retail banks, the behavioural (i.e. actual) maturity is very likely to be different from the contractual maturity. For example, some deposit liabilities may remain available to the bank beyond their contractual repayment date without any obligation or need for the bank to adjust the interest rate payable on them. Similarly, some assets of banks tend to be repaid before maturity.

31. Where empirical evidence indicates that the behavioural maturity is relatively stable over time, it is reasonable to place such items in the bands according to their estimated maturities. For example, if three-year hire purchase agreements are typically paid off in two years, they would be assigned to the two-year maturity band rather than to the three-year band. This approach would allow these items to be combined with normal banking business for risk assessment purposes.

32. For savings deposits and non-interest-bearing sight deposits, the issue is more complex. It is not only that these liabilities often remain available to the bank beyond their contractual maturity, but also that the rate is variable at the discretion of the bank or - in the case of non-interest-bearing deposits - set contractually at zero. Banks may have available to them a considerable core of transactions deposits which are largely unresponsive to interest rates and so could perhaps - from an interest rate risk perspective - properly be regarded as long-term in nature even though it would be imprudent to do so from a liquidity perspective.

33. A number of members of the Committee have experience of assessing the "stickiness" of savings deposits and sight deposits. Indeed, estimates can be made of the proportion of such deposits which tend to remain with the bank. However, while these core deposits may not respond quickly to small interest rate differentials, in the case of a significant rise in market rates a bank could not indefinitely postpone adjustment of its rates or conditions without losing the bulk of such accounts.

34. Views differ on how this information should be reflected in the measurement of risk. One alternative is for supervisors to instruct banks how to slot their core deposits according to a formula based on statistical estimates of stickiness, i.e. the proportion likely to be drawn down over a given time period in the absence of interest rate adjustments. An alternative is to allow banks freedom to slot deposits according to their own calculations of stickiness, subject to supervisory oversight, and perhaps also subject to some overall constraints, such as specifying the longest time-bands which could be used to slot each type of core deposit and the maximum amount that could be slotted into that time-band.

35. For some items, additional considerations may be required in that their behavioural maturity may change with changes in interest rates. For example, in the case of a fixed-rate mortgage where the holder can prepay without penalty, a sharp fall in rates can give rise to an increase in prepayments. For such items, estimated cash flows would be slotted based upon expected prepayment behaviour. These prepayment assumptions should reflect current estimates of expected future prepayment rates and would vary as interest rates change. The assumptions used in calculating these expected cash flows would be subject to supervisory approval. In most countries, however, this is not a significant problem either because the vast bulk of mortgages are at floating rates or because the penalties for prepayment are prohibitive.

(d) Derivatives

36. The measurement of interest rate risk in derivative products would be the same as that set out in detail in the consultative paper on market risks. Thus, all debt derivatives and off-balance-sheet instruments which react to changes in interest rates would be converted into positions in the relevant underlying as described in paragraphs 60 to 65. These would include forward rate agreements (FRAs), futures and options on debt

instruments, interest rate and cross-currency swaps and forward foreign exchange positions.

37. The treatment of options poses problems because of the asymmetrical risk and the non-linear relationship with the underlying. The most practical method of measuring the risk in options is to report options on a delta-weighted basis (or a simplified proxy of delta) and simply slot them into the maturity ladders. Although in the market risk proposals it is suggested that a further measure of risk should be added to take account of the fact that deltas do not capture all the risk of loss in trading options, the Committee feels that such complexity is not justified for the purpose of measuring interest rate risk in the banking book. It therefore favours the use of deltas alone.<sup>7</sup>

#### B. Weighting and offsetting

38. Converting the positions reported in the maturity ladder into a measure of exposure to future movements in interest rates requires assumptions to be made about likely movements in and correlations between different interest rates and the time horizon over which a bank is likely to be exposed to changes in rates before it can take action to protect its position. These assumptions can be used to determine appropriate open position weights (which indicate the riskiness of holding a single long or short position) and rules governing the offsetting of long and short positions within and across the time-bands.

##### (a) Open position weights

39. Under the market risk proposals described in the first paper in this package, positions in each time-band of the maturity ladder would be weighted by a factor designed to reflect the price sensitivity of those positions to changes in interest rates. The weighting factor is the product of two components, one based on the duration of the position and the other based on assumed changes in market yields. The time-bands and corresponding weighting factors which are being envisaged are shown in Annex 1.

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7 For small banks which do not have the capacity to calculate deltas but use options only as hedges, comment is invited on the need for a simplified alternative.

40. Although the impact of a change in interest rates may be less immediate in a bank's traditional banking business than its trading position (which are generally marked to market), it is no less real. Hence, as a starting point, the Committee proposes that the same methodology and duration weights should be applied to open positions in the banking book as to those in the trading book. A few members think that different volatility factors (i.e. the assumed change in yields) might justifiably be used because the time horizon over which the banking book should be judged is longer than that for the trading book. Most, however, believe that the range proposed in the consultative paper (1% at the short end ranging down to 0.6% at the long end) represents a reasonable estimate of the level of protection for which supervisors should be looking. The Committee invites comment on this matter and in particular on the need for a sliding scale of volatility factors.

41. The duration of a fixed-rate security, although primarily influenced by its maturity, is also influenced by its coupon. The lower the coupon, the more volatile the price. For example, in an 8% interest rate environment, the price of a 30-year zero-coupon bond is more than twice as volatile as that of a 30-year 8% bond. Slotting such bonds according to residual maturity would underestimate risk and allow offsetting between positions where substantial risk is still present. The Committee therefore proposes that securities with coupons of less than 3% should be reported separately and made subject to the higher scale of weighting factors set out Annex 1.<sup>8</sup>

42. Alternatively, it is for consideration whether institutions with the necessary capability should be permitted to measure duration by calculating the price sensitivity of each position separately and to prepare the reporting form based on duration, not on residual maturity. This would involve taking into account the exact coupon of each instrument, rather than an assumed 8% rate, and calculating duration according to the precise residual maturity of the instrument rather than the mid-point of a time-band. In principle, the greater accuracy of such a method would be welcome but banks' systems would need to be subject to supervisory oversight to ensure that the risk was being correctly measured. Other

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8 This scale in effect converts zero-coupons into the equivalent of 8% bonds.

aspects of the measurement system, for example disallowances for permissible offsetting, would be no different from the standard gap method of calculation.

(b) Offsetting within and across the time-bands

43. A fundamental issue in measuring interest rate risk is the extent to which short and long positions both within time-bands and between time-bands can be regarded as hedging each other. There is strong empirical evidence that long and short positions of equal risk-weighted size are generally less risky as a pair of positions than when considered individually: indeed, for positions of very similar maturity and bearing similar market-related interest rates, interest rate risk can virtually be eliminated. In the part of this package dealing with the treatment of debt securities in the trading book, this hedging effect is captured by permitting offsetting subject to specific disallowance factors: the smaller the disallowance, the more the offsetting of risk is recognised. It is envisaged that, for the trading book, offsetting allowances will be greatest for positions in the same maturity band ("vertical" offsets) but will also be recognised for positions in different maturity bands ("horizontal" offsets) - though as proposed these are progressively less generous as positions in the maturity ladder get further apart.

44. Similar arguments can be applied to the banking book. It is possible for mismatches and basis risk to arise within a maturity band which would not be apparent in the reported information. This suggests that full vertical offsetting might be imprudent, particularly for the shorter maturity bands where deliberate mismatching in banks' treasury operations may be concentrated. On the other hand, assuming that the objective is solely to identify outliers, the added complexity introduced by a system of disallowances may not be warranted. One test of the usefulness of disallowances is how large a role they would play in the measure of risk.

45. Those who favour vertical disallowances believe that there are, nonetheless, circumstances where full offsets might intuitively have some appeal. Mention has already been made in paragraph 29 of reference rate items, where assets and liabilities bear a rate of interest which will automatically adjust at the same time and which, if of equal amount, will be perfectly hedged.

46. There are other cases, perhaps where a bank has deliberately arranged a pair of precisely matched transactions, in which a more generous

treatment of offsetting may also be justified. It would be impractical to include sufficient detail in the reporting framework to allow supervisors to identify such hedges, but it might instead be acceptable to allow banks themselves to net closely hedged positions in the same maturity band before inclusion in the reporting form according to criteria laid down by the supervisor. Criteria could be devised to determine the closeness of maturity and coupon matching which would justify this treatment. It would be necessary, as a safeguard against abuse, to require banks to report both the gross (i.e. before offsetting) and net figures, so that supervisors could monitor the extent to which a bank's book was regarded as fully hedged and, if necessary, make occasional checks on banks' application of the criteria. Comment on the practicability of this approach is invited.

47. Similar questions arise in relation to the appropriate horizontal offsets, i.e. the permitted offsetting of matched weighted positions in different time-bands. If yields always change consistently with the assumptions behind the weights along the yield curve, complete offsetting of matched weighted positions would be appropriate. However, yields along the yield curve may not move together over quite lengthy periods.

48. In the consultative papers for debt securities in the trading book, significant recognition is given to hedging between opposite positions in time-bands that are not widely separated but only limited recognition to hedging between long and short positions at opposite ends of the maturity spectrum (see Annex 2). For the measurement of interest rate risk in the bank as a whole, some Committee members are in favour of full offsetting of equal risk-weighted positions across the maturity spectrum, on the grounds that horizontal disallowances would not have a material effect on the identification of banks most exposed to interest rate risk. A majority, however, takes the view that, as in the trading book, supervisors should not recognise full hedging across the maturity spectrum. There is, however, no consensus that the same horizontal disallowances as proposed for the trading book would necessarily be appropriate for positions in the banking book.

#### C. Integrating different reporting forms

49. Paragraphs 17 to 18 above addressed the question of whether and to what extent the trading book and the banking book should be integrated for the purpose of measuring interest rate risk. Similar questions arise in

connection with interest rate risk in different currencies and interest rate risk incurred by different affiliates.

(a) Interest rate risk in different currencies

50. The proposed reporting system would require the completion of maturity ladders for each currency,<sup>9</sup> except for those in which business is not significant.<sup>10</sup> Naturally, there may be positions in some ladders which, if in the same currency as those in others, would be treated as offsetting to a greater or lesser degree. The main issue is whether opposing interest rate positions in different currencies could indeed be regarded as hedging one another.<sup>11</sup> Clearly, interest rates of some countries (e.g. ERM currencies) show at least some degree of correlation.

51. This issue has parallels with horizontal offsetting: ideally, the recognition of hedging should reflect the correlation of interest rates. The question in this case is whether different currencies exhibit broadly similar interest rate movements with any degree of regularity. An exact measurement based on correlations of all rates in all currencies would be extremely complicated and difficult to incorporate into a measurement system. One possibility could be to group currencies into blocs that exhibit closely correlated movements. However, this could prove very complex, and the choice of currency blocs could be controversial. Also, parallelism would not be maintained with the proposals for measuring foreign exchange risk in the consultative paper on market risks, which rejects the concept of currency blocs in the context of measuring foreign exchange risk.

52. The most conservative solution would be to permit no offsetting between positions in different currencies, but this "worst case" approach is harsh and does not reflect economic reality. Available evidence suggests that correlations of interest rates in different currencies are generally

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9 Composite currencies such as the ECU or SDR could be reported as a separate currency, or at the supervisor's discretion, be disaggregated into the relevant maturity ladders according to the quotas governing the basket.

10 Comment is invited on an appropriate threshold level for "significant".

11 No offsetting of this kind is envisaged in the proposed market risks framework.

positive, but are relatively low compared with correlations for different maturities in the same currency. A majority therefore prefers an intermediate solution that would not imply extreme assumptions on correlations - that is, not as pessimistic as no offsetting, but not as optimistic as permitting full offsetting. It is suggested that comment be invited on workable methods for recognising interest rate correlations across currencies.<sup>12</sup>

(b) Treatment of positions in different affiliates

53. Bank supervisors generally prefer to include all the banking units of a group in a risk measurement system. The Committee believes that, as with any other risk, the interest rate risk banks undertake in subsidiaries and foreign branches should not escape prudential supervision. While banks may not have fully integrated interest rate risk monitoring systems that extend to all their subsidiaries and foreign branches, they should be in a position to provide information for all units that are subject to consolidated supervision, subject perhaps to a de minimis exemption for small units.

54. While, however, it provides a more comprehensive measure of risk, consolidated reporting can underestimate market risk because positions in one affiliate can offset opposite positions in another. There is, for example, no guarantee that a parent bank can withdraw profits from a subsidiary to offset its own losses. This is more crucial in assessing market risk than for credit risk, where a subsidiary's exposure will always be additive to that of the parent. National supervisors would need to be able to satisfy themselves of the legal and practical possibilities for transferring profits before allowing intra-group offsets. Moreover, they might still wish to introduce some type of limits system to avoid the possibility of over-reliance on intra-group transfers of profits.

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12 Calculation of interest rate risk for each currency would produce (a) vertical and/or horizontal disallowances which have no sign, and (b) a final residual unmatched position, which has a sign (either long or short). A possible approach favoured by one delegation would be to measure the risk as the disallowances plus the larger of the sum of short and long residual unmatched positions in individual currencies. This would represent partial offsetting and would imply that there is neither positive nor negative correlation between the interest rates in different currencies.

#### IV. DEVELOPMENT OF A REPORTING FRAMEWORK

55. Following consultation and after carefully reviewing the comments received, the Committee proposes to develop a reporting framework along the lines of the framework used for the treatment of debt securities in the trading book. The market risk proposals require banks to allocate their trading positions in securities and related derivatives to a maturity ladder divided into thirteen time-bands (see Annex 1), according to the remaining period to repricing or, for fixed-rate items, to final maturity. The Committee sees merit in adopting a similar approach for all interest-rate related assets and liabilities<sup>13</sup> (on and off-balance-sheet) in a series of maturity ladders for each currency.

56. Many positions in the banking book have special features which make them respond distinctively to changes in market interest rates. It is essential for the reliability of the subsequent measurement calculations to be able to distinguish between them in the maturity ladder so that they can be accorded an appropriate treatment.

##### (a) Amortising items

57. Depending on whether or not the supervisory authority decides to separate amortising items and treat them in a standard manner, there may need to be special breakouts for amortising items in the reporting form. This would not be necessary if institutions break down amortising items and slot them according to the appropriate repayment dates as described in paragraph 27.

##### (b) Divergent contractual and behavioural maturities

58. For certain items, as explained in paragraphs 30 to 35, while the contractual period until interest rates can be reset or the position matures may be known, there may be reason to believe that the actual term may be different because of the behaviour of depositors or borrowers. For the purposes of the reporting framework, therefore, it is suggested that such items should be separately identified. This would permit different assumptions to be made about their true maturity in assessing the interest rate risk to which the bank is exposed. Demand deposits, which as explained

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13 Non-interest-bearing assets and liabilities would be slotted into separate lines in the reporting form.

in paragraphs 32 to 34 may justify special treatment, would be separated from other liabilities.

(c) Non-interest-rate sensitive items

59. Non-interest sensitive assets and liabilities (e.g. equity or property) would be reported in special lines in the reporting form outside specific time-bands. It would seem appropriate to include interest-bearing capital liabilities (for example, subordinated debt) in the ladders alongside other banking positions, but the non-interest sensitive elements of capital (i.e. equity) would be included with non-interest bearing liabilities.

(d) Derivatives

60. Derivatives would be converted into notional on-balance-sheet positions for slotting into the maturity ladder alongside other assets and liabilities. In principle, there would be no particular reason to differentiate between off-balance-sheet items and the regular on-balance-sheet items in the reporting framework. However, for monitoring and statistical purposes, it could well be useful to identify separately the positions taken in the main derivative products, and the pro-forma reporting form makes that distinction.

61. Futures and forward contracts in the same currency, including forward rate agreements, would in principle be treated as a combination of a long and a short position in a notional government security. The maturity of a future or an FRA would be the period until delivery or exercise of the contract, plus - where applicable - the life of the underlying security. For example, if reporting at the end of June, a long position in an August three-month interest rate future would be reported as a long position with a maturity of five months and a short position with a maturity of two months. However, since the two-legged treatment for futures and forwards captures a relatively small financing cost, an alternative may be for banks to slot in the value of the securities that are deliverable against the futures contract.

62. Forward foreign exchange positions would be slotted within their appropriate currency ladders according to the maturity of the individual contracts. Thus a five-month forward contract to sell dollars for Deutsche Mark would be slotted as a short position in the three to six month band of the dollar ladder and as a long position in the three to six month band of the Deutsche Mark ladder.

63. Swaps would be treated as two notional positions in government securities with relevant maturities. For example, an interest rate swap under which a firm is receiving floating rate interest and paying fixed would be treated as a long position in a floating rate instrument of maturity equivalent to the period until the next interest fixing and a short position in a fixed-rate instrument of maturity equivalent to the residual life of the swap. The separate legs of cross-currency swaps would be reported in the relevant maturity ladders for the currencies concerned.

64. As indicated in paragraph 37, options would be reported at delta equivalents. In slotting deltas into the time-bands, a two-legged approach could be used as for other derivatives, requiring one entry at the time the underlying contract takes effect and a second at the time the underlying contract matures.

65. Floating rate instruments with caps or floors can in theory be treated as a combination of floating rate securities and a series of European-style options. For example, the holder of a three-year floating rate bond indexed to six-month LIBOR with a cap of 15% could treat it as:

- (1) a debt security that reprices in six months; and
- (2) a series of five written call options on a FRA with a basis of 15%, each with a negative sign at the time the underlying FRA takes effect and a positive sign at the time the underlying FRA matures.

However, it is recognised that this treatment may be unduly complicated and a simple alternative might be considered. For example, one possibility would be to treat instruments whose caps are more than 1% above current interest rates as floating rate instruments and those whose caps are within 1% of current interest rate levels as fixed rate instruments slotted according to their final maturities. Comments are invited on this or on alternative methodologies.

(e) Trading book items

66. As indicated in paragraphs 17 and 18, questions arise in relation to the integration of the trading and banking books. It is therefore proposed that the reporting framework should have separate lines for trading book positions.

## V. CONSULTATION

67. This paper is being circulated widely for public comment both within G-10 member countries and outside. Comments are invited on all aspects, in particular those listed below, with counter-proposals where appropriate.

### I. Policy questions

68. Question 1: Is the overall framework for addressing interest rate risk proposed here appropriate? Are there changes that would improve its effectiveness?

Question 2: Is the supervisory focus on outliers, that is, banks with extraordinarily large levels of interest rate risk, appropriate?

Question 3: Are other supervisory methods adequate to deal with banks that have moderate levels of interest rate risk?

### II. Methodology questions

69. Question 1: The measurement system favoured by a sizeable majority of Basle Committee members is designed to look at the risk of future changes in interest rates to the economic value of a bank by using a duration-weighted gap methodology.

- (a) Does this represent a satisfactory compromise between simplicity and accuracy?
- (b) Would it be an effective method of identifying outliers and what improvements would you suggest?

Question 2: A minority of Committee members prefer an alternative measurement system focused on current earnings (see paragraphs 20 to 22).

- (a) Would it be useful to supplement the basic measurement system by measuring also the risk to current earnings?
- (b) What are the views of market participants on the use at national discretion of the current earnings approach as an alternative to the economic value approach?

Question 3: Paragraphs 23 to 24 explain that the measurement system envisaged would not identify "embedded losses" caused by earlier interest rate changes but which do not show up because the assets/liabilities are recorded at book value.

- (a) Is it agreed that this is a significant aspect of interest rate risk which should be captured in some way and monitored by the supervisor?
- (b) If so, should it be addressed by the bank being required to:
  - estimate the net present value of its banking book; or to
  - track weighted average yields for its liabilities and assets in each time-band; or to
  - maintain information on the volume of fixed-rate assets at less than current market rates and their financing?

Question 4: Paragraph 18 proposes that trading positions (including off-balance-sheet instruments held for trading purposes) and non-trading positions (including off-balance-sheet instruments used to hedge non-trading positions) should be separated in measuring interest rate risk.

- (a) How far should offsetting positions between the trading and banking books in the same time-band (or overall) in the two books be recognised as hedges or partial hedges?
- (b) Should the recognition of hedges be dependent on a bank consciously managing its interest rate risk in an integrated manner or should marking to market also be an essential ingredient?

Question 5: Paragraph 27 suggests, for amortising items, that lower duration weights or a breakdown by individual repayments would be appropriate. Is this sensible, and if so, which of these reporting methods would be preferable?

Question 6: Paragraphs 30 to 35 explain the difficulties in slotting into the time-bands sight and other deposits whose behavioural and contractual maturities differ.

- (a) What would be an appropriate treatment for such items?

- (b) How can interest-reset behaviour be sensibly factored in, while limiting the potential for unrealistic assumptions?

Question 7: Paragraph 37 proposes the use of delta equivalent values in reporting options and similar instruments (e.g. interest rate caps and floors).

- (a) Is the use of deltas the best one for sophisticated institutions or would it be feasible to use options pricing models?
- (b) Should there be an alternative approach for less sophisticated institutions, similar to the one in the market risk proposals?

Question 8: The duration weights mentioned in paragraph 40 and set out in detail in Annex 1 use as one parameter an assumed 1% change in interest rates at the short end reducing to 0.6% at the long end.

- (a) Is a 1% change in interest rates sufficient protection in the light of historical interest rate volatility?
- (b) Is it appropriate to apply a sliding scale of factors to reflect the declining volatility of interest rates across the term structure or would it be better to maintain 1% protection across the maturity spectrum?
- (c) It is proposed that low-coupon items should be subject to higher duration weights. Is there a better way of dealing with these items?
- (d) Are there good reasons for applying different duration weights for different currency ladders?
- (e) What views are there on the question in paragraph 42 as to whether banks should be free to use a more sophisticated measure of duration, based on the actual coupon and maturity of each position?

Question 9: Paragraphs 44 to 46 question whether offsetting positions within the same time-bands should be regarded as risk free.

- (a) Would introducing some small vertical disallowance to account for basis risk and for mismatches within the same time-band have a material effect on the measure of interest rate risk?
- (b) If so, would it be practical to allow banks to net off closely matched items subject to the same reference rate?

Question 10: Paragraph 48 indicates that there are different views as regards full offsetting between long and short duration-weighted positions in different time-bands.

- (a) To what extent would horizontal disallowance factors add to measurement accuracy?
- (b) Would the horizontal disallowances proposed for the trading book (see Annex 2) be appropriate?

Question 11: Paragraphs 50 to 52 raise the question of recognising hedging between offsetting positions in different currencies.

- (a) Is it right, as proposed, to use different reporting ladders for each currency in which the bank has other than an insignificant position?
- (b) Should full or partial offsetting be allowed for interest rate risk run in different currencies?
- (c) As an alternative, is there a practical method of recognising interest rate correlations between different currencies?

Question 12: Paragraphs 53 and 54 express the intention of the Basle Committee to see that interest rate risk undertaken in foreign branches and subsidiaries does not escape supervision.

- (a) How far should banks be expected to measure interest rate risk on a consolidated basis?
- (b) If consolidated reporting is in operation, is full offsetting appropriate?

Question 13: The reporting framework envisaged in Section IV would comprise thirteen time-bands and may incorporate up to three cash-flow categories (amortising, non-amortising and deep discount).

- (a) Is the number of time-bands appropriate?
- (b) Should there be a smaller or larger number of specific cash-flow categories than the three mentioned?
- (c) Does the extra accuracy justify using a two-legged system to slot derivative products into the time-bands as suggested in paragraphs 61 to 64?

- (d) What simple alternatives are there for the treatment of floating rate instruments subject to caps or floors set out in paragraph 65?

70. Comments on these questions and on any other aspect of the ideas described in the paper should be submitted to national banking supervisory authorities to arrive before end-1993. The responses will be assembled at national level and put forward to the Basle Committee for further consideration of the issues. Depending on the outcome of the consultation process and of progress in the field of market risks more generally, implementation of a consistent reporting framework might then proceed.

Annex 1

Weights for interest rate risk in the market risk proposals

The table below sets out the risk weights which are being envisaged for the net open positions (long or short) in each time-band.

<u>Coupon 3% or more</u>	<u>Coupon less than 3%</u>	<u>Duration weight (A)</u>	<u>Assumed change in yields (B)</u>	<u>Risk weight (A) x (B)</u>
up to 1 mo.	up to 1 mo.	0.00	1.00	0.00%
1 to 3 mos	1 to 3 mos	0.20	1.00	0.20%
3 to 6 mos	3 to 6 mos	0.40	1.00	0.40%
6 to 12 mos	6 to 12 mos	0.70	1.00	0.70%
1 to 2 yrs	1.0 to 1.9 yrs	1.40	0.90	1.25%
2 to 3 yrs	1.9 to 2.8 yrs	2.20	0.80	1.75%
3 to 4 yrs	2.8 to 3.6 yrs	3.00	0.75	2.25%
4 to 5 yrs	3.6 to 4.3 yrs	3.65	0.75	2.75%
5 to 7 yrs	4.3 to 5.7 yrs	4.65	0.70	3.25%
7 to 10 yrs	5.7 to 7.3 yrs	5.80	0.65	3.75%
10 to 15 yrs	7.3 to 9.3 yrs	7.50	0.60	4.50%
15 to 20 yrs	9.3 to 10.6 yrs	8.75	0.60	5.25%
over 20 yrs	10.6 to 12 yrs	10.00	0.60	6.00%
	12 to 20 yrs	13.50	0.60	8.00%
	over 20 yrs	21.00	0.60	12.50%

Horizontal offsetting of debt securities  
in the market risk proposals

The proposal groups time-bands into three zones as indicated below.

Partial offsetting would be permitted between weighted long and short positions in each zone, subject to the matched portion attracting a disallowance factor that is part of the capital charge. The disallowance proposed within zone 1 is 40%, applied to one side of the matched amount. Within zones 2 and 3 the disallowance would be 30%.

The remaining net position in each zone would be carried over and offset against opposite positions in other zones, where the process is repeated. The proposed disallowance factor between adjacent zones is 40%. The disallowance between non-adjacent zones would be 150%, meaning that 25% of a matched position could be regarded as hedged.

	<u>Time-band</u>	<u>within</u> <u>the zone</u>	<u>between</u> <u>adjacent zones</u>	<u>between</u> <u>zones 1 and 3</u>
Zone 1	0 - 1 mo.			
	1 - 3 mos	40%		
	3 - 6 mos			
	6 - 12 mos		40%	
Zone 2	1 - 2 yrs			
	2 - 3 yrs	30%		150%
	3 - 4 yrs			
	4 - 5 yrs		40%	
Zone 3	5 - 7 yrs			
	7 - 10 yrs			
	10 - 15 yrs	30%		
	15 - 20 yrs			
	over 20 yrs			

Glossary

Amortising instruments: instruments which return both principal and interest on a predetermined basis over the life of the instrument.

Basis risk: the risk that the relationship between the prices of two similar, but not identical, instruments will change. Thus, even if maturities are perfectly matched, basis risk could remain.

Counterparty risk: the risk that the counterparty to a financial contract will not meet the terms of the contract.

Currency swap: a transaction involving an initial exchange of principal of two different currencies. Interest payments are exchanged over the life of the contract and the principal amounts are repaid either at maturity or according to a predetermined amortisation schedule.

Delta: the expected change of an option's price as a proportion of a small change in the price of the underlying instrument. An option whose price changes by \$1 for every \$2 change in the price of the underlying has a delta of 0.5. The delta rises toward 1.0 for options that are deep in-the-money and approaches 0 for deep out-of-the-money options.

Duration: a mathematical concept designed to measure the price sensitivity of debt securities to small parallel changes in interest rates. Specifically, duration is the weighted average maturity of all payments of a security, coupons plus principal, where the weights are the discounted present values of the payments. Modified duration is duration divided by a factor of one plus the interest rate.

Embedded losses: locked-in losses caused by past movements in interest rates but not yet recognised in accounts that are carried at historic cost.

Forward: a commitment to buy (sell) an asset at a future date for a price determined at the time of commitment, usually reflecting the net cost of carry. May be applied to currencies, equities, commodities or other assets.

Forward rate agreement (FRA): a contract in which two counterparties agree on the interest rate to be paid on a notional deposit of specified maturity at a specific future time. Normally, no principal exchanges are involved, and the difference between the contracted rate and the prevailing rate is settled in cash.

Futures contract: an exchange-traded contract generally calling for

delivery of a specified amount of a particular grade of commodity or financial instrument at a fixed date in the future.

General market risk: the risk of a general market movement arising from, for example, a change in interest rates or official policy.

Hedge: to reduce risk by taking a position which offsets existing or anticipated exposure to a change in market rates or prices.

Instruments subject to behavioural maturities: items whose contractual terms do not accurately reflect expected behaviour, for example loans which may be prepayable at the borrower's discretion or deposits which may be left with the bank beyond the contractual repayment date.

Interest rate cap (or floor): an option-like feature for which the buyer pays a fee or premium to obtain protection against a rise (or fall) in a particular interest rate above (or below) a certain level.

Interest rate mismatch: a difference in the repricing schedule of positions which exposes the institution to interest rate risk.

Interest rate risk: the risk that changes in market interest rates might adversely affect an institution's financial condition.

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

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

Market risk: the risk of losses in on- and off-balance-sheet positions arising from movements in market prices, including interest rates, exchange rates and equity values.

Non-amortising instruments: instruments which return the full principal amount upon maturity.

Off-balance-sheet activities: banks' business that does not generally involve booking assets or liabilities. Examples include trading in swaps, options, futures and foreign exchange forwards<sup>14</sup>, and the granting of stand-by commitments and letters of credit.

Option: the contractual right, but not the obligation, to buy or sell a

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14 For certain countries, some of these items may be on the balance sheet.

specified amount of a given financial instrument at a fixed price before or at a designated future date. A call option confers on the holder the right to buy the financial instrument. A put option involves the right to sell the financial instrument.

Prepayment: a payment of principal made before the scheduled payment date. For example, a houseowner may prepay a mortgage because the house has been refinanced or sold.

Reference rate (or Administered rate) business: banking transactions that are not subject to a fixed interest rate for a given term but whose interest rates are linked to some reference rate (e.g. prime rate) and therefore change at unpredictable intervals.

Swap: a financial transaction in which two counterparties agree to exchange streams of payments over time according to a predetermined rule.

Trading book: an institution's proprietary positions in financial instruments which are taken on with the intention of benefiting in the short term from actual or expected differences between their buying and selling prices or of hedging other elements of the trading book, or which are held for short-term resale, or in order to execute a trade with a customer.

Volatility: a measure of the variability of the price of an asset, usually defined as the annualised standard deviation of the natural log of asset prices.

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

Zero coupon bonds: securities which do not make periodic interest payments and are redeemed at face value at a specified maturity date. These securities are sold at a deep discount, and the return accrues to the buyer as the security gradually appreciates.