Risk measurement and capital requirements for banks

By Patricia Jackson of the Bank's Regulatory Policy Division.

As part of their efforts to improve their risk control, the major banks are developing new statistically based tests to measure some of the risks they face. Although they are re-examining the risks in traditional lending and borrowing activities, progress has so far been greatest in the measurement of the position risk in securities and derivatives trading books. This article reviews developments in both areas, and compares the two main types of test being developed for trading books—value at risk models and 'stress tests'. It also looks at the way that the value at risk models are influencing the development of international capital standards.

The main recent developments have been:

- *Banks have used statistical techniques to look at the risks in different parts of their trading books for some time, but a number are now using more sophisticated, value at risk (VAR) models and 'stress tests' to look at the risks in the whole trading book. Large securities houses are developing these approaches in a similar way.*

- *In 'traditional banking business' (mainly lending and its deposit funding), the most significant change has been in the management of the embedded interest rate risk. Most large banks now manage this in their trading books, enabling it to be hedged actively.*

- *The growing sophistication of some banks' measurement of their overall trading risks has led the Basle Committee on Banking Supervision to consider allowing them to use their internal VAR models to determine the capital required to back their trading positions.*

Background

The nature and scale of the risks that banks face vary across the range of their activities. In their 'traditional banking business'—lending financed by deposits from customers or the wholesale markets—the main risks are: the *credit risk* on loans (the risk that the borrower will default); *liquidity risk* (which arises when the maturity profiles of assets and liabilities differ); the *interest rate risk*, if there is a difference between the interest rate structure of loans and deposits; and *operational risk* (for instance the risk of fraud or error). Almost all banks account for this part of their business on a cost basis, less provisions if an asset is impaired.

In recent years, banks have, in addition, become increasingly involved in the trading of securities and derivatives. These trading activities give rise primarily to *position*, or *market, risk*—the risk that a change in the prices of the securities or derivatives in which a bank has a position will cause a loss. Because trading-book exposures are taken with a view to resale or short-term profit, rather than to holding the securities until maturity, the assets are treated as short-term and valued on a mark-to-market basis, ie at the current price at which they could be sold in the market, which enables the risks to be managed.

Because the risks that banks face in their traditional business mainly arise from their loanbooks, these were the focus of the first international initiatives to agree minimum capital requirements, which led to the 1988 Basle Capital Accord. The approach in the Accord provided the basis for the European Union's Solvency Ratio and Own Funds Directives. Under it, all private-sector assets carry a set capital charge related to credit risk—8% in general, but less for interbank and mortgage lending—to give a capital requirement for a diversified loanbook.(1) Within trading books, only on balance sheet positions bear this credit risk charge for their full amount; short positions in private-sector securities (which are treated as liabilities), and all positions in government securities (which are assumed to have minimal credit risk), are excluded.(2) Positions in some

(1) For UK banks, the capital requirement may be above the minimum set in the Accord, because required capital ratios are not set automatically at 8%, but depend on the strength of a bank's systems, its assets and management.
(2) The United Kingdom, however, sets capital requirements for long and short government bond positions, because it is considered essential to take the position risk into account.

off balance sheet items are covered by requirements for counterparty risk (which cover the replacement cost if a counterparty reneges). But there is no allowance for the hedging of securities positions, which would not have fitted within the credit risk structure of the requirements.

The building-block approach for trading books

It was always envisaged that the Basle standard would need to be adjusted to provide a more appropriate treatment for the risks in banks' trading books, and for some time the Basle Committee has been considering this.(1) In addition, in the European Union the Commission was seeking a common approach to the treatment of banks and securities houses' trading books, driven by the need for an agreed capital standard for securities firms, which will—under the terms of the Investment Services Directive—for the first time be able to set up branches throughout the European Union on the basis of a 'passport' given by authorisation in one member state.

For a number of years, the Basle Committee and the European Union worked in parallel on a treatment similar to the risk-based approach of securities supervisors such as the Securities and Futures Authority. The Capital Adequacy Directive, finally agreed in 1993, set out the EU approach for the trading books of banks and securities firms;(2) and at roughly the same time, the Basle Committee published proposals to apply to international banks in the Group of Ten countries, Luxembourg and Switzerland. The approach allows for hedging within markets (for example of UK interest rate risk), but not for hedging or diversification between markets (for example between UK and US interest rate risk).

This approach was based on what was then regarded as the most appropriate way of setting capital standards for trading positions. It uses historical data on price movements to calculate the capital needed to cover, say, 95% of movements over a two-week period; this is then set down as a percentage capital requirement for a particular position. Such calculations had previously been carried out by several securities regulators, and their requirements informed the decisions taken in the European Union and in Basle.

The fundamental structure is, therefore, additive and is known as the *building-block approach*. The capital requirement for pure interest rate risk on exposures in a particular bond market is calculated taking into account the maturity of the bonds and hedging allowances. To this is added a specific risk charge for the non-government instruments in the book. The total requirement for that book is then added to the requirements for the positions in every other bond market in which a firm has an exposure, to those for each equity and foreign exchange book, and to the total counterparty risk requirement.

Although the underlying figures for the risks in a market are broadly based on a two-week holding period and a 95% *confidence interval*, the overall result for a well-diversified book is a much greater margin of comfort. This is because it is very unlikely that a firm would simultaneously suffer an equally adverse movement affecting all the elements of its trading book—each individual bond, equity, and foreign exchange market, and its counterparty exposures. The requirements had, however, to be sufficient to cover specialist players operating in only one market, as well as diversified firms.

The treatment allowed a more sophisticated approach in one area: in-house 'pre-processing models' may be used to convert derivative positions into positions in their underlying bonds or equities, which can be slotted into the basic approach. In addition, a models approach was permitted for foreign exchange positions, enabling firms to use past data to estimate likely losses.

Overall, the building-block approach to trading-book risks represents a substantial advance on the Basle Accord, because it produces a capital requirement which is broadly risk-based—at least for the individual parts of the book—and takes into account hedges within markets.

But banks have developed their own systems for measuring market risk considerably in recent years. This has led the Basle Committee to consider going beyond this proposed treatment to offer an alternative approach. Rather than laying down detailed capital requirements for trading-book positions, the approach would allow banks to use their own models to estimate the likely losses on positions and calculate their capital requirements. This would enable the capital requirements to reflect portfolio effects (for example, from hedging or diversifying between the UK and US bond markets). The use of banks' own models in this way would, however, be subject to safeguards concerning the nature of the models themselves and the controls applied to their use.

Banking-book risks

Interest rate risk

There has been a marked change over the last ten years or so in the way banks manage the interest rate risk within their 'traditional' banking books. Interest rate risk arises here where there is a difference between the interest rate structure of a loan and of the funds being used to finance it. Where such a difference exists, the interest cost of the funding will not necessarily move in tandem with the interest earned. If a five-year fixed-rate loan is funded using three-month deposits,(3) for example, there is a substantial interest rate risk because the rate on the deposits could vary over the life of the loan. There is a similar—though smaller—risk if a

(1) The Basle Committee on Banking Supervision is a committee of banking supervisory authorities established in 1975 by the central bank governors of the Group of Ten countries.
(2) The Capital Adequacy Directive contains an explicit definition of the *trading book*, which does not necessarily correspond exactly to individual banks' own definitions.
(3) Most lending in the United Kingdom is floating-rate, but in the past five years a substantial market in fixed-rate mortgages and loans to small companies has developed.

five-year loan carrying a floating rate of interest that is re-fixed every six months is funded using three-month deposits. And even if the term and interest-reset dates of the liabilities and assets are the same, interest rate risk still arises where the *bases* of the interest rate are not the same—where, for instance, a loan with a variable interest rate set by reference to the base lending rate is funded using deposits carrying a Libor rate.(1)

Because banking books are valued at cost and not current market value, it is difficult to monitor and hedge their overall interest rate exposure from day to day. One possible answer to this would be for a bank to value them, at least in its management accounts, on a net present value basis;(2) this would allow the total risk to be hedged using market-value items. If such an approach were used in published accounts, however, it would—among other problems—not conform to the accounting convention that assets not held for trading should be valued at historic cost.

Banks have developed other approaches to the problem. One approach, in principle at least, is to match the interest term of each loan exactly with that of the funds used to finance it (match funding), so ensuring that a bank's interest rate exposure arises to a large extent in its trading book, where it can be accounted for on a mark-to-market basis. But this is rather cumbersome in practice.

An alternative, now used by many banks, is to manage the interest rate risk in the trading book rather than the banking book. To achieve this, the trading arm of the bank provides hedging instruments for the banking book which exactly fill the interest rate gaps in that book. For example, if a banking book contains loans carrying interest rates reset every six months funded using three-month deposits, the exposure to a change in rates in three months' time can be removed from it by the banking arm 'purchasing' a forward rate agreement (FRA) from the trading arm, which assumes the risk.(3) The FRA is accounted for on an accruals basis in the banking book (consistent with the historic cost treatment) and on a market-value basis in the trading book. This allows the risk to be hedged in the trading book using market-value derivatives (or other instruments), in the same way as any other trading exposure. A clear advantage of this approach is that it enables a bank's total interest rate exposure (from both trading and lending activities) to be measured and managed centrally.

Credit and operational risks

A number of banks are also working on more sophisticated methods for measuring credit risk. The objective is to gain a better understanding of the likely (ie expected mean) losses on particular categories of loan over their life, and also of the likely variation in these—the magnitude of unexpected losses. The aim would then be for the likely losses to be more than covered by the spread over the cost of funding charged by the bank; unexpected losses would be met from capital. An essential element in the approach is that loan officers should grade loan requests using a scoring system that is calibrated according to the likely percentage loss on that class of business, and that this is reflected in the interest rate set. The system would also be used to update the grading of outstanding loans; the calibration of loan-grading systems in this way is relatively new.

The likely default rates of large companies can be estimated using data on the likely default of companies with particular credit ratings. A scoring system is used to impute a bond rating for those companies that are not rated. For other credits, banks are obliged to use their own internal data. A number are at present working to extract from the available data information on losses from homogeneous categories of loan; the extent of progress with this varies.

Some banks are developing similar methods to measure *operational risks*—such as the risk of errors in transactions with customers, or of fraud. At present, many use a rule of thumb to determine their capital allocation for operational risks—for example a percentage of the volume of transactions. Others use 'scenario analysis', looking at events which could lead to large operational risks and the size of the possible losses.

Trading risks

VAR models

The area where there has been the greatest change in the measurement of risk in recent years is securities and derivatives trading. The development of liquid derivatives markets has given banks the tools to control their risk profile more closely; and this has been paralleled by the development of more sophisticated in-house systems to measure the risk inherent in a particular book.

In the past, banks have usually measured the risks in individual parts of their trading books separately. But now they are increasingly moving towards a whole trading book approach—using a *value at risk* (VAR) model. The aim of a VAR model is to calculate on a consistent basis the *likely* loss that a bank might experience on its whole trading book, allowing for the hedges that exist between—as well as within—different markets. VAR models assess likely price changes of instruments within individual markets and at the extent to which prices in one market vary with those in others; some are more comprehensive than others in attempting this assessment.

(1) Libor is the interest rate at which wholesale deposits are offered to banks in the London money market, as measured by samples of the rates at which deposits are offered to representative major banks. Base lending rate is an administered reference rate, which determines the interest rate on some loans, set by clearing banks in relation to the cost of their wholesale funding (eg Libor). Changes in base lending rate are less frequent than moves in wholesale market rates.
(2) The net present value (NPV) of a loan (or deposit) is the value of the future cash flows discounted using current interest rates for loans (or deposits) of that maturity. The current market value of an interest rate related security reflects this NPV, any specific risk related to the issuer and risks related to the market, for example liquidity risk.
(3) A forward rate agreement is a contract in which two parties agree on the interest rate to be paid on a notional deposit of specified maturity at a specific future time. It enables the buyer to protect itself against a rise in interest rates and the seller against an interest rate fall.

Value at risk models

This box describes in more detail the two value at risk (VAR) modelling techniques discussed in the main article.

Variance/covariance analysis uses summary statistics, calculated from historic data on price volatilities and correlations within and between markets, to estimate likely potential losses. Price changes are assumed to be normally distributed; this enables a bank to calculate a confidence level—a figure for the value at risk over the next 24 hours that it can be, say, 95% or 99% confident will not be exceeded. The confidence level is calculated by reference to the standard deviation of past percentage price changes multiplied by a scaling factor.

To give an example, if a bank has positions in interest rate related instruments—bonds, swaps, forward rate agreements etc—in three markets (the United Kingdom, the United States and Germany), the following statistics will be calculated for each market; they might run to many thousands if a full variance/covariance approach were being used:

- the volatilities of government bond prices in a large number of maturity bands—for example, the standard deviation of daily percentage price changes—converted to a 99% confidence interval by multiplying by 2.3;(1)
- correlations in price movements between the maturity bands (ie along the yield curve) in each market;
- the relationship between price changes in corporate and government securities (in essence, the risk on corporate exposures is separated into the pure interest rate risk on government bonds, and the spread between government and corporate bonds); and
- correlations in price movements between markets.

In order to use these summary statistics to calculate the value at risk from interest rate exposures in a particular market, the portfolio will be broken down into a number of maturity bands. A bank will have a rule enabling nearly identical risks to be netted off against one another. Using sensitivity models, other exposures (for example, large swap books) are reduced to a small number of bond positions with sensitivity to interest rates very similar to the cash flows from the swaps. The bond positions can then be used as a proxy for the swap positions, and are placed in the maturity bands.

To look at the exposure of the total bond book (across all the bond markets), the correlations between price changes at each point in the yield curve in the different markets are calculated. This technique is applied to equity books in a similar way: for a bank's equity positions in each market, the likely volatility (given a 99% confidence interval) of the index is calculated, as is the likely correlation between movements in the indices in different markets. The VAR approach can also be used to capture the *beta* risk—the risk that prices of individual equities will not move exactly in line with the index. Similarly, the currency position risk arising from the securities positions is captured by calculating the volatility of each currency and the correlations between them. And, depending on how comprehensive the VAR model is, the interest rate, equity and foreign exchange exposures may all be considered together to give an overall picture of likely losses, by calculating the correlations between price movements in the separate risk groups.

It is difficult to allow fully for the non-linear risks arising in option portfolios—exposures in gamma(2)—using this technique. The approach implicitly assumes that a portfolio's value varies linearly with changes in market level. This is clearly not the case with options, and the problem is particularly significant when there are large market movements.

The other method of VAR modelling is *historical simulation*. Here, the trading book is reduced to its essential elements (using maturity bands for the interest rate exposures, as in the first approach). Historical data covering two years or so is then used to calculate the changes in the value of the book that *would* have been experienced had it been held throughout the period. (It is not possible simply to revalue the current book over the past, without reducing it to its essential elements, because data on all individual bonds and equities is usually not stored over long periods by the banks; in any case, in earlier periods some bonds would not have been in existence. Even if the bond *had* been in existence, its residual maturity would have been different in earlier periods, leading to different price volatilities.) Using this technique, it is possible to calculate the 99% confidence interval *without* assuming that the price changes are normally distributed, by computing the loss which was not exceeded on 99% of occasions.

Clearly, a main difference between the two approaches is that with the first the confidence interval is calculated statistically, whereas with historical simulation it is observed. The variance/covariance method uses the assumption that the price changes are normally distributed to derive the confidence level; that assumption is not, however, entirely realistic, since prices tend to exhibit more extreme movements than is consistent with a normal distribution (the observed distribution has fatter tails than a true normal distribution). By assuming normality, therefore, the approach may understate the likely volatility.

Another difference is that the simulation method can encompass the spread and basis risk between instruments, and can also be expanded to encompass the non-linear gamma risks in option portfolios.(3)

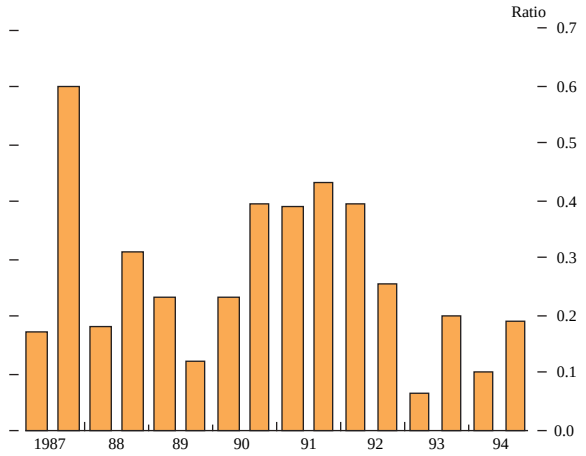
(1) Since the returns are assumed to be normally distributed, there is a 1% probability that the return will be greater than 2.326 standard deviations from its mean.
(2) The *delta* of an option is the rate of change of its price with respect to changes in the price of the underlying asset. Its *gamma* is the rate of change of the value of the option with respect to its delta.
(3) The *spread risk* is the risk of a change in the spread between corporate and government bond prices; the *basis risk* is the risk that, where a position is hedged using a position in a non-identical instrument, the prices of the two positions will move differently.

There are two main VAR approaches: variance/covariance and simulation. Under the variance/covariance approach, a bank uses summary statistics on the magnitude of past price movements and correlations between price movements to estimate likely potential losses in its portfolio of trading-book positions. Under the simulation approach, a bank bases its expectation of potential future losses on calculations—using data on past price movements—of the losses that would have been sustained on that book in the past. Banks can use either approach to allocate the capital between their various operations. They can also use them to see how particular exposures change their value at risk. The box on page 180 describes VAR models in more detail.

One issue with VAR models is how they treat correlations. The variance/covariance approach cannot reflect the substantial variation in correlations between markets seen in different periods; instead it is based on average correlations calculated for the whole data period. The simulation approach reflects the actual correlations seen on particular days, but where extreme changes in correlation coincide with periods of extreme volatility, they are likely to fall outside the 99% confidence interval used and so outside the VAR test itself—although they can still be observed.

In some extreme periods, such as during the October 1987 crash in equity markets, the correlation between major markets has been close to 1: all the markets moved together. There is little benefit at such times from diversification between markets, but considerable benefit from having long and short positions in different markets. At other times—for example after the 1987 crash, when the Nikkei equity index fell alone—the correlation between some markets has been closer to 0, or even -1. The benefits from diversification are then greater, but those from hedging are considerably reduced. In the past seven years, the average correlation between the Nikkei and FT-SE 100 indices has been 0.32, but the correlations calculated over six-month periods have varied between 0.07 and 0.6—as Chart 1 shows.

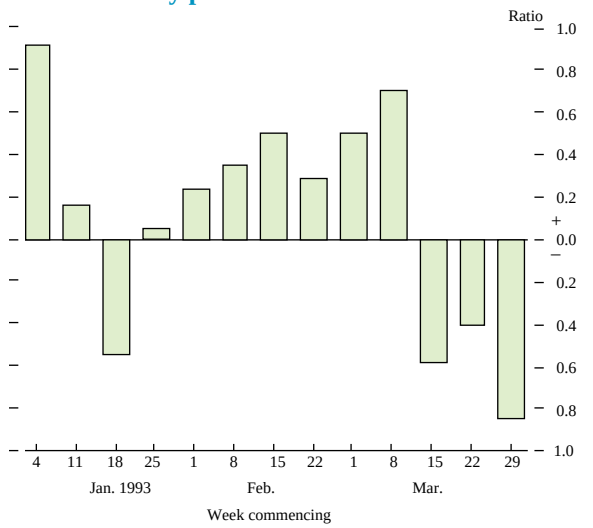
Chart 1
Correlations between Japanese and UK equity indices: six-month periods(a)



(a) Average correlations between percentage daily changes in the Nikkei 225 and FT-SE 100 stock market indices calculated over six-monthly periods.

The variation in the correlation between the two markets was even greater over shorter periods. In the first quarter of 1993, for example, the weekly correlations varied from +0.9 to -0.9 (see Chart 2); there was a similar pattern in the first quarter of 1994.

Chart 2
Correlations between Japanese and UK equity indices: weekly periods(a)



(a) Average correlations between percentage daily changes in the Nikkei 225 and FT-SE 100 stock market indices calculated over weekly periods.

For the risk profile of a trading book, it is short-term rather than longer-term correlations that are important; with daily marking to market of positions, hedges must be effective over weeks rather than quarters.

Stress tests

VAR models are only part of the risk measurement armoury, however. The other main part are 'stress tests', used to look at the effects on a trading book of extreme market movements. Stress tests calculate the *possible* extent of exposures under extreme assumptions (rather than the *likely* loss). The trading book is revalued according to imposed parameters, rather than according to summary statistics calculated from past data as in the VAR variance/covariance approach. The differences with the VAR approach are highlighted in the table below.

VAR variance/covariance models and stress tests

Feature	VAR variance/covariance model	Stress test
Volatility (intra-market by maturity band)	Calculated statistically	Volatility imposed
Correlations between maturity bands	Calculated statistically	Twists in the yield curve imposed
Spread risk between governments and companies	Calculated statistically	May or may not be calculated statistically
Correlations between markets	Calculated statistically	Imposed

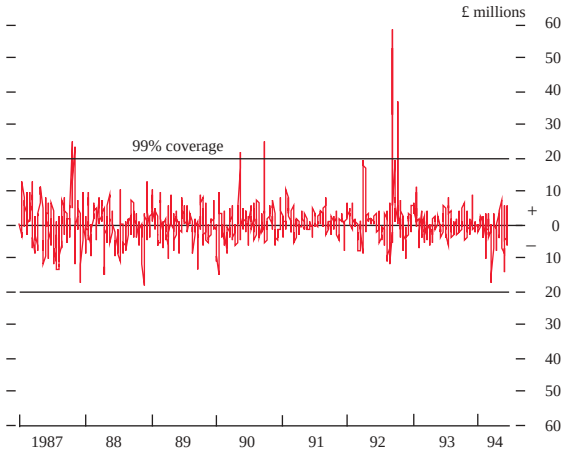
Stress tests look explicitly at the effects of extreme movements in markets. Firms decide on several scenarios which, though unlikely, are possible—a *spike* period—and calculate the hypothetical loss on their trading books in these

circumstances. Some banks use the most risky plausible scenario for their current book. Others use standard tests—for example a 1% shift in interest rates along the yield curve, combined with particular assumptions about shifts in the yield curve (eg short rates moving more than long rates) in all markets and a 10% fall in equity markets. Some also use as stress tests a move of four standard deviations for each variable in the VAR model. Parameters in option-pricing models are usually moved in line, although some firms are starting to model volatility changes (for input to these models) separately.

Those banks that have adopted the VAR simulation approach can use their data on the daily profits and losses which would have been made had the book been held over the past two or three years to look at all the spike periods. They can then consider how likely movements of that scale are over the next 24 hours, and hedge if it is thought appropriate.

Chart 3 shows, as an example, the profits and losses which would have been made over weekly periods in the past seven years on a stylised UK gilt book. The horizontal lines show the profit/loss which was not exceeded on 99% of occasions. As can be seen, there were several spike periods which would have produced profits/losses in excess of the 99% level. The largest were at the time that sterling entered the ERM—when there was a 1% parallel shift in interest rates along the yield curve—and when its membership was suspended, when there was a 10% movement in interest rates at the short maturities. This highlights the need for banks to use stress tests as well as the VAR approach.

Chart 3
Gains/losses on a stylised gilt portfolio(a)



(a) With a weekly holding period.

Many major banks now carry out stress tests on their trading books, but to date fewer have full VAR models. Some have a series of systems that produce separate figures for different parts of the book—covering interest rate, foreign exchange and equity position risk—which have to be combined (perhaps by adding them) to give the total value at risk. Among those with more comprehensive VAR models, a number still fall short of using a full matrix of correlations.

VAR models can be more easily created for the trading books than for the credit risk in the banking books, because the data needed are more readily available and the risks more homogeneous. Most firms have been storing data on securities prices to formulate hedging strategies, and these can be used to calculate the value at risk. Not all data are easily available, however; for example, many firms do not have a time series of implied volatilities for use in the option-pricing calculations in the simulations.

Future developments on capital requirements

Banks

The Basle Committee is now considering whether in-house VAR models could provide the basis for an alternative approach to the setting of capital requirements for banks' trading books. The main advantage of such an approach would be that it would not generate excessive capital requirements for a widely diversified book in the way that the simple additive structure does. It would also reward sophisticated risk management and work with the grain of firms' own risk management techniques. The Committee's proposals are set out in the consultation paper, 'Proposal to issue a supplement to the Basle Capital Accord to cover market risks.'

One problem, however, is that even where banks' VAR models are built along similar lines, they use different parameters: some may cover price changes over monthly periods, others daily; some may include a 95% confidence interval, and others 99%. Likewise the period of data used for the basis of the calculation can vary widely. And in making the calculation, firms may rely to different extents on weak correlations between markets.

To reduce the differences between models, the Basle Committee is proposing to fix a number of the parameters to govern the way in which the models are specified. These might include the following:

- the use of price changes over a two-week period as the basis for the price volatility calculations;
- a minimum sample period of one year for the past data;
- a 99% one-tailed confidence interval; and
- a requirement to take into account in some way the non-linear behaviour of option prices.

Fixing these parameters, however, would not address the problem that the historical correlations used in VAR models to assess the benefits of hedging and diversification between markets may not hold in extreme (stress) periods. Within a risk category (for example, interest rate risk across a number of markets), the Basle Committee is proposing to allow banks to use the correlations within and between markets that they deem appropriate, provided that their supervisor is satisfied with the process for calculating them. But no hedging or diversification allowances will be permitted between different risk groups: the outcomes of the VAR

Management systems and controls

The Basle Committee is proposing that each supervisor should specify a number of qualitative criteria which banks would have to meet before they could be permitted to use a models-based approach. These criteria would include the following:

- A bank should have an independent risk control unit responsible for the design and implementation of its risk management system. The unit should report directly to senior management, and evaluate the relationship between measures of risk exposure and trading limits. It should also conduct regular back testing—comparison between the risk measure generated by the model and the actual profit and loss.
- Senior management must be actively involved in risk control and review the daily reports produced by the independent risk control unit.
- The risk measurement model must be closely integrated in day-to-day risk management.
- The results of the programme of stress tests should be reviewed by senior management, and be reflected in the policies and limits set by management and the board of directors.
- An independent review of the risk measurement system should be carried out regularly in the bank's internal auditing.

model for each risk group will simply be added together. Despite this, it is recognised that the output of the VAR models may well not provide sufficient comfort for stress periods, and the Committee is considering requiring banks to apply a factor of three to the output to reach an appropriate capital requirement.

As a further safeguard, the Committee is proposing that banks applying the VAR approach must also use a rigorous and comprehensive stress-testing programme covering a range of possibilities which could create extraordinary losses or gains. The stress tests would cover extreme price changes—such as those at the time of the 1987 equity market crash and the suspension of sterling's membership of the ERM in 1992. They would also cover extreme movements in the correlations between markets. A bank would have to convince its supervisors that it had a regular stress-testing programme before its in-house model was recognised for use in setting capital requirements. As another check on the adequacy of the VAR approach, it is also proposed to require banks to report information on the largest losses experienced during the reporting period, which could be compared with the capital requirement for the same dates produced by the VAR model.

Finally, the Committee is also proposing to set extensive qualitative standards for those firms using models, particularly with regard to their management systems and controls; the box opposite summarises what is being proposed. Without effective systems and controls, the models themselves, however accurately they purport to measure risk, are almost useless.

A move towards the use of more sophisticated models for setting capital requirements would be likely to affect banks' attitudes towards risk diversification and hedging. Capital requirements that encourage risk-reducing behaviour provide an incentive for firms to take this sort of action. With time, such an approach to capital standards would encourage more firms to develop sophisticated risk management techniques and to view the risks to which they are exposed in a more sophisticated way.

Securities firms

The proposal to use in-house models and stress tests is not confined to banks. Some of the US securities houses may in future use a combination of the output from VAR models and stress tests to provide reports to the SEC on their affiliated derivatives companies. As with the Basle proposals, the VAR models will cover losses calculated over a two-week holding period with a 99% confidence interval, though no extra multiplying factor will be applied to the overall result. The firms will also carry out stress tests but, in contrast to the Basle proposals, these will be on a number of specified core risk factors and the results of the tests will be reported to the SEC. The firms will calculate the change in value of all positions as a result of the specified movements. This approach has recently been set out in the Framework for Voluntary Oversight by the Derivatives Policy Group.

Comparison of the building-block and VAR and stress-test approaches

The building-block approach to capital requirements for trading books, as embodied in the Capital Adequacy Directive, is based on statistical data and particularly on past price volatilities. In its hedging allowances, it also reflects assumptions about the extent to which hedges between non-identical instruments are likely to reduce risk. But, broadly, it views the risk in each part of the book separately, rather than looking at the extent of the overall risks.

In contrast, the VAR approach—rather than assuming that the risks in different geographical markets for, say, bonds should simply be added together (on the assumption that a firm could face adverse developments in each market simultaneously(1)—calculates the past correlation between movements in the different markets and uses this to estimate the extent of the *overall* risks faced.

(1) The effect is to assume that if a firm is hedged (ie long and short) between two markets, those markets could move in opposite directions, giving no benefit; and that if a firm is diversified—with long positions in two markets—the markets could move together, giving no benefit.

The approach that the Basle Committee is considering would not go as far as firms' own models, which in some cases take account of correlations not only between geographical markets in the same risk class (eg interest rate items), but also between risk classes (interest rate items, equities and foreign exchange)—for example the correlation between price changes in sterling bonds and US equities.

Another difference between the VAR model and building-block approaches as set out in the CAD is that, although the Directive's capital requirements are based on statistical information on price volatilities, its requirements are general. There are not separate requirements to reflect markets' differing volatilities: no distinction is drawn, for example, between the volatility of the Japanese and UK equity markets, although in the recent past the Japanese market has been more volatile. VAR models, in contrast, take the price data—and therefore the different volatilities—of individual markets into account. Similarly, they are likely to measure spread and basis risk in particular markets more accurately than the building-block approach.

There is also a difference in the way that exceptional price movements are covered. Like the VAR approach, the building-block method does not seek to cover 100% of possible price moves instrument by instrument. However, because its requirements are additive, the method results in a much greater margin of comfort for a whole book, unless it is very specialised. This is one reason for the Basle Committee's caution about the ways in which VAR models may be used. It also underlines the importance of firms assessing possible losses using stress tests that assume extreme volatilities in prices and correlations in a number of markets.