The management of market risks

Prices on the financial markets are constantly changing. Major changes and financial crises can arise suddenly and without warning. At the same time, almost all of the banks' assets and liabilities are exposed in some way to the prices on these markets. This means that the banks risk losing large sums in a short period of time if they do not have efficiently functioning systems for managing these risks, known as market risks. The management of market risks as part of the banks' risk management has come under increasing focus over the past few decades. It is currently the most well-developed form of risk management and the banks have considerable scope for measuring, managing and controlling these risks.

The Riksbank has discussed the Swedish banking groups' management of credit risks, counterparty and settlement risks, operational risks and liquidity risks in earlier Financial Stability Reports.

This special topic concludes the mapping of the different types of risk faced by the banks. It describes first of all where and in what forms market risks arise within the banks. This is followed by a description of the models used to measure risks and how the banks work to control and limit them. Finally, there is a discussion of the extent of market risks in the Swedish banking system and of whether this could comprise a threat to financial stability.

Channels for market risk within the banks

Market risk is the risk of loss as a result of unprofitable developments on the financial markets, primarily those for interest rates, shares and foreign currency. All assets and liabilities are sensitive to changes in market prices. Market risk can be expressed as either *value risk* or *earnings risk*. The value risk is most evident in the cases where the banks hold market-valued assets and liabilities. Here a change in market variables has a direct effect on the value of the assets and liabilities in the balance sheet. In the cases where the positions are not market valued, a change in market prices will not be reflected in the accounts until the positions are realised, i.e. in the form of earnings. Regardless of the form of accounting, however, the effect on the actual value of the asset or liability, and thereby the bank's actual value, is the same. Earnings risks also include risks that depend on changes in demand for the bank's services as a result of changes in market variables, e.g. the demand for share-related services.

VALUE RISK – EXPOSURE VIA THE BALANCE SHEET

A bank's assets can generally be divided into a banking book and a trading book, as illustrated in Table 3. The *banking book* comprises the bank's lending to the general public. The value of this lending is dependent on several factors, for instance, the borrowers' credit standing, interest rates and also exchange rates, if the loans are in foreign currency. When these factors change, the actual value of the banking book is also affected. Changes in the exchange rate are directly reflected in the accounts, while changes in the interest rate are not shown immediately. Instead, they are expressed in the form of a change in earnings over time and are thus not a value risk in terms of accounting. In addition to the direct effect of changing interest rates and exchange rates on the value of the banking book, changes in market prices can also have an indirect effect on the *credit risk* in the banking book, as borrowers and the value of collateral are affected by changed market prices.

The trading book is the part of the bank's assets used for setting prices on financial assets within the bank's regular operations, i.e. in the form of bid rates and offer rates to customers and for the bank's internal transactions, as well as liquidity management. This means that it is also used to some extent for taking positions. The trading book consists of various forms of traded assets, such as bonds, shares, currencies and different types of derivative instruments. If their market prices develop in a direction that is not beneficial to the bank, the value of the trading book falls. These changes in value are reflected directly in the balance sheet. The market risk in the trading book is thus a value risk, both actual and from an accounting perspective.

On top of these two main asset classes, the banks also have a limited holding of bonds and shares outside of the trading book. These are primarily a long-term holding.

The bank's liabilities consist in principle of deposits and issued securities. The value of the liabilities depends on the interest rate and also the exchange rate, if the liability is in a foreign currency. When these factors change, the value of the liabilities is affected in the same way as the value of the assets.

TABLE 3. ILLUSTRATIVE BALANCE SHEET

Assets		**Liabilities and equity**	
Banking book	75 %	Deposits and borrowing	45 %
Trading book	10 %	Issued securities	35 %
Other financial assets	2 %	Other liabilities*	16 %
Other assets*	13 %	Equity	4 %

* These consist mainly of assets and liabilities that offset one another, which results in a lower net value. For instance, assets in insurance activities, where the insured party bears the risk of a corresponding value on the liability side, and values in derivative contracts.

Exposures to market risk in assets and liabilities to some extent offset one another in the balance sheet, which results in the banks' net exposure being considerably lower than their gross exposure. If the assets decline in value as the result of, for instance, higher interest rates or a change in the exchange rate, then the liabilities usually

follow the same pattern. The risks are also reduced by the diversification effects between different asset positions. There are well-developed methods for measuring net exposure and the effect of diversification. This is discussed below under methods to quantify market risk. In addition to the reduction in market risk that stems from the bank itself holding both assets and liabilities, the banks use various forms of instruments and limits to control their exposure to market risk. This is discussed below under risk organisation, limits and control.

EARNINGS RISK – EXPOSURE VIA THE INCOME STATEMENT

Expressed in simple terms, a bank's income consists of net interest income, net commission income and net transaction income. The value of each of these items is partly dependent on developments in market prices.

Net interest income is the difference between the bank's interest income and interest expenditure, which in traditional banking operations is the most important income item. Changes in interest rates affect net interest income. The effect on this item of a change in interest rates, and the time taken until this change is reflected, are mainly determined by two factors; the difference in volume between interest-bearing assets and liabilities and in their interest rate adjustment periods.[39]

The net income from the financial transactions in the trading book, known as *net transaction income*, comprises the total of both realised and unrealised profits and losses during the period. Net transaction income thus directly reflects the change in value that arises as a result of changes in market variables in the balance sheet, unlike net interest income, which in time transfers the effect of changed interest rates on non-market valued assets to the balance sheets.

Net commission income comprises income from charges, brokerage, commission, etc. It is not traditionally included in the discussions of market risk. However, as net commission income is strongly connected to developments on the stock markets, it is appropriate to include it in these discussions. The relationship to developments on the stock market is explained by the fact that approximately one half of commission income stems from brokerage and charges for management of securities and mutual funds, which are taken out as a percentage of their value. Lower share prices lead to a lower turnover and thereby lower income from brokerage, and also to lower values for the assets managed and thereby lower management income. The banks often exact charges in foreign exchange and interest rate transactions in the form of margins on the price, which is reflected in the net transaction income.

Table 4 provides a summary of the channels and mechanisms through which market risks can influence the banks' balance sheets

39 As a rule these two have directly opposite effects in the banks. Normally, the value of interest-bearing assets is higher than the value of interest-bearing liabilities, which means that higher interest rates have a positive effect on net interest income. However, the assets' interest rates are normally fixed for a longer time period than the liabilities', which means that higher interest rates have a negative effect on net interest income.

and income statements. The three main types of market risk; interest rate risk, currency risk and equity risk, are described below.

TABLE 4. CHANNELS FOR MARKET PRICES

A change in: **Interest rates** affects:	**Exchange rates** affects:	**Share prices** affects:	Leads to a change in:
Value risk			
The value of assets and liabilities.	The value of assets and liabilities calculated in SEK.	The value of shareholdings.	**The values of assets and liabilities.**
The interest coverage ratio among borrowers. The value of collateral pledged. The counterparty exposure in derivative contracts.	Borrowers' foreign exchange exposure. The counterparty exposure in derivative contracts.	Borrowers' exposure to the stock market. Borrowers' market value. The value of collateral pledged. The counterparty exposure in derivative contracts.	**Credit risk** (indirect effect on the value of assets)
Earnings risk			
The interest income and expenditure.	The value in SEK of interest rates in foreign currency.	–	**Net interest income**
The value of interest-bearing assets and liabilities.	The value of assets and liabilities in SEK.	The value of shareholdings.	**Net transaction income**
–	The value in SEK of commission income in foreign currency.	The demand for share-related services. The value of assets under management.	**Net commission income**

INTEREST RATE RISK, CURRENCY RISK AND EQUITY RISK

The interest rate risk is the most complex market risk and that which dominates in Swedish banks, both in terms of gross exposure and net exposure, as well as from an earnings risk perspective. One reason for the high level of gross exposure is that the values of all assets and liabilities are sensitive to changes in the interest rate. This is because the value of an asset, or a liability, is equal to the value of its discounted expected future cash flow. A situation with higher interest rates thus entails a lower value for the asset or liability, given that other conditions remain the same. Another reason for the high level of gross exposure is that interest-bearing assets and liabilities comprise the majority of the bank's assets and liabilities, which means that interest income and expenditure account for the greater part of a bank's income and cost flows.

An institution is liable to interest rate risk if the interest sensitivity of its assets and liabilities is not matched. Interest rate risk arises primarily because the bank's interest-bearing assets and liabilities have different interst rate adjustment periods. This risk is called the *repricing risk* and is both a market value risk and an earnings risk.[40]

Even if the repricing risk were eliminated, there could still be

40 If the interest rate adjustment period for the liabilities is shorter than that for the assets, the bank is forced, when interest rates rise, to pay the higher rate on the liabilities before it can begin to benefit from the higher interest income from the assets. See also the previous footnote.

interest rate risks in the form of yield curve risk and basis risk. *The yield curve risk* is the risk of changes in the slope and shape of the yield curve. When the relationship between long and short rates changes, there is a risk that any matches between interest rates with different maturities will cease to exist and thereby pave the way for new interest rate risks.

The basis risk is the risk that interest rates on assets and liabilities with the same repricing profile are not perfectly correlated, in other words, an interest rate change can have a different impact on different interest-bearing positions with the same repricing profile. However, the basis risk often works to the banks' advantage. When interest rates rise, for instance, the banks are usually able to raise their deposit rates less and more slowly than their lending rates.

The currency risk is the risk of loss when the exchange rate for foreign currencies changes. The bank's net exposure to currency risk is quite simply its open position in foreign currency. The banks have a substantial gross exposure to currency risk, although net exposure is usually low.

The equity risk is the least significant market risk in Swedish banks in terms of gross exposure. The equity risk is the risk of loss when share prices change. This risk can be either specific, which means that it comes from an individual share, or related to the risk of loss from price changes on the market as a whole.

Methods for quantifying market risk

Market risk is mostly measured from value risk perspective, regardless of whether the positions in the balance sheet are market-valued or not. Almost all assets and liabilities are usually included in this measure. However, an exception is normally made for strategic shareholdings, as these are assets that are not meant to be realised. Most methods used by the banks to calculate market risk are based on a value risk perspective, with only a few being based on an earnings risk perspective.

The simplest methods for quantifying market risk are sensitivity measures that monitor any impact in the value of a position if the market price of an underlying variable changes. The more developed methods, especially Value-at-Risk (VaR), allow the banks to observe changes in a number of market variables at the same time and thereby also capture any correlation and diversification effects between the types of risk.

SENSITIVITY MEASURES

Sensitivity measures calculate how much the value of assets and liabilities is affected by a particular change in an underlying market variable, e.g. an interest rate change of +/– 50 points, a change in the exchange rate of +/– 5 per cents or a change in the share index of +/– 5 per cent, while other variables remain constant.

Option risks are often measured by means of *risk matrices*. The value of the option instrument is not solely dependent on the value of the underlying market price, but also on the volatility of the market

price. Risk matrices are similar to ordinary sensitivity measures, with the difference that both the market price and its volatility change. These two variables comprise the axes of the matrix. It is then possible to see in the matrix the change in value that arises from different combinations of changes in these two variables.

Sensitivity measures for interest rate risks

The banks' standard measure for calculating interest rate risk is *delta-1*. Delta-1 measures the change in the value of assets and liabilities in a parallel upward shift of one percentage point of the yield curve. A duration calculation is normally used for this. An asset's modified duration is its sensitivity to a small change in the interest rate. If the assets' duration is longer than that of the liabilities, which is most often the case for banks, a higher interest rate will result in the assets falling more in value, in terms of per cent, than the liabilities. As the change in value of a position sensitive to interest rates is not linearly related to changes in the interest rate, this calculation is normally supplemented with an adjustment to the convexity of the yield curve.

When interest rate risk is calculated according to delta-1, only the repricing risk is captured, not the yield curve risk or the basis risk. The banks can gain some impression of the yield curve risk by measuring the change in value on certain hypothetical changes in the slope of the curve, or through using VaR calculations.

A further measure of interest rate risk is the effect of a parallel shift of the yield curve on *net interest income* over a period of one year. This measure is based on the restrictive assumptions that the change will continue for a year and that there will be no change in the composition of the portfolio during that time. Nor does the measure take into account, for instance, how savers would act if the interest rate was lower. It is possible that they would move money from their savings accounts to other forms of saving, such as mutual funds or shares. This would force the banks to find other, more expensive financing.

VALUE-AT-RISK

VaR is a statistical risk measure that has become widely used among the banks and other financial market participants since the early 1990s. This method is based on calculations of possible future changes in value based on historical experiences. Different methods of calculating VaR are discussed in-depth in a special box.

The advantage of this method over other risk measures is that it can measure all market risks in the same way, i.e. interest rate risk, currency risk and equity risk, and also aggregate them. This makes it possible to use one figure to summarise the total market risk of a portfolio. Another advantage is that it is easy to understand the content of the measure and to communicate it. As VaR is a probability-based risk measure, it is also possible to verify the accuracy of the model.

VaR provides the information that the losses with an x per cent probability do not exceed SEK y during a period of z days, if the composition of the portfolio remains unchanged. A VaR value of

SEK 50 million for a portfolio thus means that there is a 99 per cent probability that the portfolio will fall by a maximum of SEK 50 million in one day if VaR is measured with a one-day holding period and a confidence level of 99 per cent. One day of 100, i.e. two to three days a year, the decline in value is expected to be greater than in the VaR value in the example above. The VaR value thus states the highest normal change in value, but says nothing with regard to extreme changes in value.

Under normal market conditions the VaR models' prediction capacity is good and as long as the users are aware of the models' limitations, VaR models can increase the understanding of the risks involved in various operations.

In addition to the models' limitation of only measuring normal losses, they are based on two assumptions that can weaken the models' usability in connection with larger disturbances and changes on the markets. Firstly, the models normally assume that the markets are liquid even during substantial changes in market variables and that it is thus possible to implement large transactions without any effect on the price.[41] Secondly, the models predict future developments on the basis of historical events and relationships, which means that they cannot correctly describe the risks during periods when events deviate from earlier patterns. It is thus important to supplement the VaR measure with other risk measures that also take into account loss risks hidden by these two assumptions. This is mainly done by means of stress tests.

STRESS TESTS

Stress tests are a collective name for methods of measuring the size of losses that would arise if an improbable, but conceivable, event occurred. These improbable events are not captured in the normal measuring methods. They can involve, for instance, sizeable losses that occur less often than every 99th day and are thus not included in the VaR measure, or changes in prices and volatility above those measured by sensitivity measures, or that the correlations used in other risk measures cease to exist. There are different types of stress test. The most common are stressed sensitivity tests and historical and hypothetical scenario analyses.

Stressed sensitivity tests entail the banks making larger, more improbable assumptions of changes in market prices than in the traditional use of sensitivity measures. A further development of the stressed sensitivity tests is what are known as *mechanical tests*, which compute a large number of possible changes in prices or market variables to find the most unprofitable result for the portfolio. These mechanical tests can in certain cases provide an indication of the probability of the events. The simplest form of mechanical test is what is known as the *factor push analysis*. The idea here is to push the price of each instrument in the portfolio in the most unprofitable direction and calculate the combined effect of this movement of all instruments in the portfolio. The first step is to determine a confidence level and then move the prices of the instruments as many

41 See also the box on market risk management and self-reinforcing sales spirals.

standard deviations as correspond to the confidence level. The least profitable price change (up or down) for each instrument is totalled to obtain the effect for the portfolio as a whole. The advantage of this method is that it generates the worst possible outcome and emphasises the vulnerable areas in the portfolio, as well as enabling various assumptions on correlations to be included. In these cases it is also possible to obtain an understanding of the probability of such an outcome. The disadvantage is that the information on actual market price movements in extreme events and correlations is limited, which means that the test could show an incorrect picture of the risks.

In the case of *scenario analyses*, either a historical or a hypothetical crisis scenario is applied to the current positions. With scenarios based on historical crises, the assumptions on changes in prices and correlations are based on actual data, which helps make the scenario realistic. The disadvantage is that it looks back in time and may have lost relevance in that markets and institutional structures change and participants may have learnt from previous experiences. Hypothetical scenarios have the advantage of allowing greater flexibility in the design of possible events and they can be adapted to perceived threats. The disadvantage, however, is that it is difficult to know whether the events one is testing for are relevant and how the relationships would look in a crisis.

Stress tests are a necessary complement to the traditional risk measures, as they help the banks to test events and scenarios that could perhaps threaten their solvency and are not captured by the traditional measures. The banks thereby gain an increased understanding of the potential threats and under what conditions these could materialise, which increases their capacity to protect themselves against them.

As with the use of other measures, it is important to be aware of the models' limitations to be able to interpret the results correctly and utilise them as a basis for decision making. Stress tests do not provide any, or at least only limited, information on the probability of the various stress scenarios. It is also difficult to determine whether the tests are relevant to the prevailing portfolio and whether they test for the correct risk factors. The uncertainty above all concerns whether the test disregards an event that risks occurring and if it correctly takes into account the risks of contagion effects between different risk types. A poorly specified stress test can give rise to a false sense of security by underestimating the risks, which could in the worst case lead to increased risk-taking.

THREE VALUE-AT-RISK MODELS

There are three main types of VaR models; variance/covariance models, historical simulation models and Monte Carlo models, which all have their advantages and disadvantages. It is not unusual for them to be used parallel with one another or in combination with one another.

Variance/covariance models are based on the assumption of normal distribution of changes in market prices and portfolio value. A linear relationship (delta) is used to approximate the change in value of the portfolio as a function of the change in market prices.[42] The normal distribution assumption means that when market prices' variance and covariance are estimated, and thereby the portfolio value's variance, it is easy to calculate the probability levels for the outcome over different time horizons. The variance/covariance model is best suited to a portfolio that contains direct positions in currencies, shares and bonds, or positions that have a linear dependence on underlying market variables, such as currency forwards and interest rate swaps.

The main advantage of the variance/covariance approach is the speed of the calculations, as the normal distribution assumption enables the desired confidence level to be derived as soon as the standard deviation of the portfolio is known. The speed and simplicity facilitate sensitivity analyses and continuous updating of the VaR values.

The weaknesses with this model are that it has difficulty capturing the risks that arise from options holdings and that the assumption that market price changes have normal distribution has proved to underestimate the probability of extreme outcomes. In reality, the tails of the probability curve are fatter than with normal distribution, which means that the model generally underestimates the risk in the portfolio. However, it can be concluded in brief that as long as the portfolio does not contain large options holdings it is possible to use the variance/covariance approach.

Historical simulation models use historical price changes to calculate the probability of price changes in the current portfolio. To deduce a probability distribu-

42 The value of a portfolio's interest-bearing assets does not have a linear relationship to changes in the interest rate. An adjustment for this can be made by including a Taylor expansion in the model. Another alternative is to base the model on changes in artificial bond prices (derived from changes in the interest rate).

tion of possible outcomes for the current portfolio, the change in value of the portfolio is calculated at the same percentage price change in positions as each day in an historical sample, e.g. the three previous years. In order to obtain the value that the portfolio will not fall below with a certain probability, the desired percentile in the simulated portfolio results is studied. In other words, a level of 95 per cent is read as the value above which 95 per cent of the cases came out.

The advantage of the historical approach is that it correctly reproduces the historical probability distribution for the market variables and thereby takes into account options risks, fat tails, etc. In addition, it generates a complete probability distribution for the portfolio's yield, which facilitates analysis. This method is instinctively very appealing and the results are easily communicated. However, it does have a number of weaknesses. For instance, it is not possible to make more simulations than there are days in the database, making sensitivity analyses is complicated as the calculation for the entire portfolio has to be redone, and it can be difficult to use this method for market variables when there is a lack of historical data.

Monte Carlo models randomly produce possible values for positions in the portfolio on the basis of historical fluctuations. Like the historical simulations, the Monte Carlo models are full valuation models, i.e. they calculate the actual portfolio value given different scenarios, and thereby produce a complete probability distribution for possible portfolio outcomes.

The model can include options, even the most complex forms of derivative instrument, and the random formulae can be adapted to other assumptions on the development of prices than normal distribution. In principle, however, the same variances and covariances can be used as in the variance/covariance approach, and the results should then be identical if the portfolio does not contain options.

The Monte Carlo approach is the most time-consuming and requires the most resources and is thus the most expensive. It is also complex and makes considerable demands of those responsible for its operations. The complexity of the model also leads to a lower transparency and understanding of the model's results.

Risk organisation, limits and control

The banks have strict internal regulatory frameworks for controlling and limiting market risks. The major Swedish banks all work in similar ways to control how much market risk is allowed to accumulate in different divisions of the bank. The board of directors sets overall limits as to how much market risk the group can accept. These limits are set per risk type, i.e. interest rate risk, currency risk and equity risk. SEB also supplements the separate limits with an aggregate limit for all market risk. The banks use different methods to define the group limits. Nordea uses a VaR measure as its main method, while FöreningsSparbanken (Swedbank) and Handelsbanken use sensitivity measures. SEB uses sensitivity measures for the separate limits and a VaR measure for the aggregate limit.

A central risk management division then distributes the risk scope under the limits among the different divisions within the bank. In principle there are two divisions that receive the entire scope; the internal bank (interest rate and currency risk) and the trading department (interest rate, currency and equity risk). The other divisions are given only minor limits. They instead let these two central divisions implement the transactions that result in market risks and thus bear the risks. If a local branch office needs to borrow money in dollars, for example, it will take out a loan for the corresponding amount via the internal bank and thus neutralise its own dollar and interest rate exposure.

The internal bank can in turn choose to either neutralise the risk completely or partly by making a matching transaction on the market or to retain the risk if its limits allow this. As the currency limits are usually much lower than the interest rate limit, the currency risk is normally eliminated through, for instance, FX swaps. The greater part of the interest rate risk in the group is reduced in that the interest rate adjustment periods in the lending and borrowing have to be matched as far as possible. However, the limits leave scope for the internal bank to allow the financing to have a shorter interest rate adjustment period than the assets and thus utilise the slope of the yield curve. The bank manages the undesired interest rate risk that remains primarily through interest rate swaps.

The clear exception with regard to limits is the foreign subsidiary banks, which can have substantial limits for market risk. However, the risk for the group as a whole is consolidated daily by a central risk division within the group.

In addition to the central limits, the divisions themselves can decide to work with internal limits, e.g. per trader and product. These limits can be defined in different ways. The limits at, for instance, the trading department are normally set for the portfolio as a whole, for the respective type of exposure and for individual positions. The internal bank and the trading department calculate their risks continually. They primarily use VaR for this, but option risks are normally measured with risk matrices. Various types of sensitivity measure are also used as a complement.

It is primarily the value risks that are limited.[43] The only major Swedish bank that uses limits for earnings risks is Nordea, which has a limit for net interest income exposure based on the sensitivity of net interest income to a parallel shift in the yield curve. The net commission risk linked to developments on the stock markets is something several of the banks follow on an ad hoc basis, but they do not try to limit or reduce it. The most important explanation for the lack of hedging of net commission income levels is that exposure to shares is perceived as the core business providing the commission income. It could also be difficult to hedge for this in terms of accounting, as the outcome of a hedge, e.g. in the form of an OMX put option, would affect net transaction income.

Stress tests have become an increasingly important part of the banks' risk measurement. They are mainly used to identify and communicate vulnerabilities to extraordinary economic and financial events. The results are reported regularly to the central risk management division, but are not used to set limits.

CAPITAL ADEQUACY RULES

In addition to the banks' own supervision of market risk exposure, there are internationally agreed rules with regard to how much capital the banks must hold as a buffer against market risks. This is regulated by the Basel Capital Accord, which specifies capital cover for market risk and came into force in 1996. The capital requirement for market risk applies only to risks in the trading book, with the exception of currency risks, for which the bank's entire risk exposure requires capital cover. According to the Basel Capital Accord, banks can choose to calculate their capital requirement either by means of their own VaR calculations after approval by the respective country's supervisory authority or by means of a standardised approach.[44]

The standardised approach is based on simplified sensitivity measures and uses a building block principle. First, the capital requirement for interest rate risk, currency risk and equity risk is determined separately and then the separate values are added to the total capital adequacy requirement. This method does not take into account the diversification effects between the different risk types. Because this method is based on simplified assumptions, it is mainly used for settlement and to a lesser extent for the banks' internal risk management. The capital requirement for market risk comprises only a small part of the Swedish banks' total capital requirement. This is due to their limited market risk exposure in the trading book.

43 VaR limits for the trading book could be seen as an earnings risk limit for net transaction income.

44 At the end of 2001, SEB was the first Swedish bank to receive approval from the Swedish Financial Supervisory Authority to use its own VaR model to calculate the capital adequacy requirement.

MARKET RISK MANAGEMENT AND SELF-REINFORCING SALES SPIRALS[45]

In recent years, there have been some occasions of extreme price changes on the financial markets, for instance, the stock market crash in 1987, the ERM crisis in 1992 and the Russian crisis in 1998. When these types of financial shocks have occurred there has been discussion as to whether self-reinforcing sales spirals have contributed to worsening problems on the markets concerned.

The methods and control systems developed to manage market risk have become increasingly sophisticated. When these methods are applied by a large number of market participants at once, they can contribute to reinforcing trends on the financial markets and in extreme cases add to the generation of self-reinforcing sales spirals. However, it is important to emphasise that the development and spread of these methods in most cases reduces the risks in the system more than reinforcing them, and that their significance in generating this phenomenon is unclear. Thus, the effects should not be overestimated, particularly under normal circumstances on the markets, but nor should they be ignored.

Below follows a discussion of how the methods for risk management could in theory contribute to the generation of self-reinforcing sales spirals.

Collateral and margin-calls. Borrowing against financial assets as collateral is often connected with a requirement that the position be sold or further collateral provided if the value of the asset falls below a certain level. The more a financial market falls, the more demands there may be to close the positions. Each closure will increase the pressure to sell on the market. If prices fall or market volatility increases, financiers may in addition choose to apply a higher collateral margin when valuing collateral to protect themselves against sudden price falls. This higher collateral requirement could also add to the negative market movement as the access to financing declines and the requirement to close positions increases further.

45 For further information on market risk and self-reinforcing sales spirals, see: A. Persaud, "Sending the herd off the cliff edge: the disturbing interaction between herding and market-sensitive risk management practices", 2000; CFGS, Structural Aspects of Market Liquidity from a Financial Stability Perspective, 2001; CFGS, *A Review of Financial Market Events in Autumn 1998*, 1999; Bank of England, Financial Stability Review. Nov 1999, Risk Management with Interdependent Choice.

More restrictive risk assessment. When drastic price falls occur and volatility increases, financiers tend to become more restrictive in their scrutiny of counterparts and amounts. This can have a number of consequences. Apart from a decline in the general access to capital, investors may also be forced to sell positions to pay back loans that cannot be renewed, even if they assess the prices to be unjustifiably low. Banks and insurance companies could, for instance, also be forced to reduce their exposure to market risks, i.e. sell off financial assets, to signal to customers that their savings and premiums were not under threat.

Stop-loss limits and VaR limits. Investors can use various forms of limits to reduce their losses in the event of a fall in prices. Stop-loss limits mean that when the loss reaches a certain predetermined level, the position is sold off to avoid further losses. Such strategies reinforce downward price trends. Another form of limits is VaR limits, which comprise the internally set limits for the VaR values. Higher volatility and correlation lead to higher VaR values. To avoid exceeding the VaR limit, it is necessary to sell volatile assets and invest in less volatile assets. This leads to further increased volatility on the already volatile markets, and to correlations between these markets rising, while risk premiums for the stable assets fall, what is known as a *flight to quality*.

The use of historical relationships. Historical relationships are easy to measure and therefore used to approximate future relationships. During periods of market stress, there is a risk that these relationships will change. If the historical relationships no longer apply and new correlations arise, earlier diversification effects and hedges may cease to exist. Repositioning of the assets is then required to reduce the increased risk in the portfolio. This usually leads to increased pressure to sell on an already stressed market. A clear example of this is *flight to quality*. If the risk in lower quality papers has been hedged against highly correlated better quality papers (through proxy hedges), the earlier positive correlation is turned into a negative one and to bring down the risk in this position it is necessary to sell the less qualitative (e.g. Danish mortgage bonds – German treasury bonds 1998).

Similar and relative incentive programmes. Many managers of market instruments receive compensation in relation to the development of the portfolio relative to some form of index. During periods with a risk of major

losses and high uncertainty, it is a safe strategy from this perspective to follow other participants' behaviour, which strengthens prevailing market movements; "... investors and bankers are more likely to be sacked for being wrong and alone than being wrong and in company."[46]

Homogenous trading strategies and decision support models. There is a risk that increasingly standardised risk models will lead to events being assessed in more similar ways and that different participants' behaviour will become more uniform. There is also a tendency towards fashions in trading strategies, which can be partly explained by the design of the incentive programmes. The more similarly the participants in a market behave, the more severe the fluctuations in the market will be. When there is severe market turbulence it is more common to make decisions daily on limits for the following day's trade, based on the day's results. There is a risk that these decisions will become auto-correlated and largely strategic. If trading becomes based on strategic reasoning, less importance is given to fundamental assessments of assets and more to the risk of other participants deciding to sell.

Capital adequacy requirement. The capital adequacy requirement for market risk is based on the market price of the assets, which could make it more difficult for investors to wait for what they consider to be an exaggerated price fall before selling. Higher volatility and correlation will result in higher capital adequacy requirements (if the bank uses VaR models for capital cover) and lower market values will lead to less capital to use for capital cover.

One of the consequences for calculation of market risk when self-reinforcing sales spirals arise is that VaR calculations and other statistical risk models may lose relevance in connection with variance and covariance no longer agreeing with the assumptions in the models. Another consequence is that almost all models are based on the assumption that changes on the market are stated exogenously, which is a reasonable assumption under normal market conditions. In times of self-reinforcing sales spirals, however, the market price depends to a greater extent than usual on the behaviour of individual participants. Their expected behaviour then becomes a decision-making variable for the other participants, whose behaviour in turn affects the other participants' decisions. The individual participant will in this case perceive that the development of market prices

46 A. Persaud, 2000.

is partly dependent on its own decisions, which makes the uncertainty strategic.

Self-reinforcing sales spirals in the meaning used here are unusual and fall outside of what traditional sensitivity measures and VaR calculations are expected to capture, which have worked well in measuring the risks in the event of more common disturbances and shocks. Participants are obliged to turn to various forms of stress test to capture the effects of these rarer events.

Even if it is possible to demonstrate a number of different mechanisms as to how self-reinforcing sales spirals can arise and be reinforced, it is important to remember that it is difficult to show their actual significance in the financial crises of recent years. The risk that the Swedish banks will be seriously affected by this type of problem is limited by the fact that the major part of their traded financial assets is comprised of Swedish treasury bonds and mortgage bonds. These are very liquid to start with, not least because they can be used as collateral in the Riksbank, which reduces the risk of self-reinforcing sales spirals.

The scope of the risks

VALUE RISK

Value risks as a result of market risk in the Swedish banking groups appear to be limited. Interest rate risk is the most extensive market risk in the system. It is, however, far from being a threat to the system, regardless of whether it is measured by the relatively restrictive delta-1 calculation or by the less restrictive VaR measure. Other risks are even more limited.

TABLE 5. VALUE SENSITIVITY, ALL ASSETS AND LIABILITIES, 31 DECEMBER 2001 (MSEK)

	Value sensitivity* Yield curve + 100 points (delta-1)	Value sensitivity SEK +/– 5%
SEB	– 2 200	–
Nordea	–	–
Handelsbanken	– 659	– 1
Föreningssparbanken	– 913	– 89

* All interest-bearing assets and liabilities. Source: Annual reports for 2001.

TABLE 6. DAILY VAR (99%/1 DAY), EXCL. OPTION RISKS, 2001 (MSEK)

	SEB[1]			Nordea[2]			Handelsbanken[3]			Föreningssparbanken[4]
	(min	mean	max)	(min	mean	max)	(min	mean	max)	
Interest rate risk	21	40	53	141	223	368	19	39	66[3]	–
Currency risk	4	8	18	1	19	52				–
Equity risk	1	5	8	187	269	364	1	6	16	–
Total (after diversification)	25	42	52	–	–	–	19	37	66	–

[1] SEB only trading portfolio.
[2] All assets, excl. business and credit-related shareholdings.
[3] Only Handelsbanken Markets, combined VaR for interest rate and currency risk. SEB and Nordea state VaR values for 10 days, below they are converted according to $VaR1d = VaR10d/\sqrt{10}$; Source: Annual reports for 2001.
[4] Not available.

Equity risk outside of the trading book is slight, as Swedish banks' right to own shares is limited by law. As shown in Table 7, Nordea has a higher exposure to financial current assets than other banks outside of the trading book because of Finnish legislation and the bank's large shareholdings in its insurance business.

TABLE 7. SHARES AND PARTICIPATIONS, MSEK (% OF EQUITY), 31 DECEMBER 2001

	SEB	Nordea	Handelsbanken	Föreningssparbanken
Trading book	7 389 (17%)	3 665 (3%)	10 785 (22%)	2 391 (6%)
Other financial current assets	1 180 (3%)*	3 507 (3%)	97 (0%)	225 (1%)
Financial fixed assets		493 (0%)	2 887 (6%)	1 946 (5%)
Associated companies	1 658 (4%)	4 446 (4%)	300 (1%)	3 137 (8%)
Total	10 227 (23%)	12 111 (9%)	14 069 (29%)	7 699 (21%)

* Financial current assets + financial fixed assets. Source: Annual reports for 2001.

A special case of market risk exposure is the banks' ownership of *life insurance companies*. Regardless of whether the life insurance companies are profit distributing companies or mutual insurance companies, the bank can have a higher risk exposure to market risk in

these companies than is reflected in its legal responsibility. This risk exposure consists of the cost the bank would experience by being connected to a failed life insurance company, e.g. in the form of lower confidence from customers and financiers. Thus, if the insurance companies cannot meet the capital adequacy requirements for the guaranteed part of the dividends to insurance policy holders, the banks might feel obliged to provide capital to avoid liquidation of the company. However, it would require extreme price falls on the stock markets over a long period of time, combined with an unfavourable development in interest rates, for this risk to materialise, and for the levels to be significant.

The indirect exposure to market risk that exists through credit risk can materialise through several different channels and is difficult to quantify. If the market price of financial assets falls, the banks risk seeing lower solvency levels among their borrowers, e.g. households' savings would decline as a result of a lower value on their share or bond portfolio, or companies' market value would fall. The risk of loan losses may also increase if the value of collateral accepted in connection with loans falls. Higher interest rates lead to companies and households with loans at variable interest rates facing higher interest rate expenditure and their credit standing may deteriorate. Changes in exchange rate affect the credit standing of import and export-oriented companies by influencing their competitiveness. Changes in market prices can also lead to an increase in counterparty exposures in various forms of derivative contracts, which entails greater credit risk.

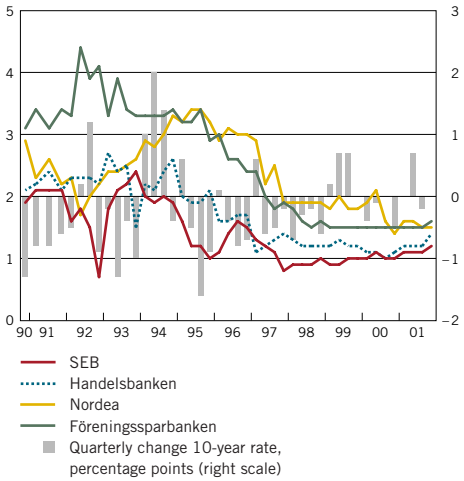
Higher interest rates or a change in the exchange rate or share prices as isolated incidents should not affect loan losses to such an extent that the stability of the system is threatened. In order to comprise a threat to the system, the loan losses would probably need to be the result of a general economic downturn. In that case, they would involve risks that should be captured in the banks' credit risk management.

EARNINGS RISK

Figure 48 shows that net interest income is relatively stable in relation to interest rate changes, even during the turbulence on the Swedish interest rate market in 1992. This stability can be explained by the fact that the banks can raise the lending rate in advance and postpone raises in the deposit rate. In addition, the banks have a buffer against unforeseen changes in the interest rate in the form of the gap between the deposit and lending rates.

Table 8 reports the sensitivity of the banks' net interest income to changes in the yield curve. According to this measure, net interest income should be affected positively or not at all by higher interest rates. This means that the positive effect of the interest-bearing assets being greater than the interest-bearing liabilities either neutralises or dominates over the negative effect of the interest-bearing assets having a longer interest rate adjustment period than the interest-bearing liabilities.

Figure 48. Net interest income in relation to total assets.
Per cent and percentage points



Note. The series for Föreningssparbanken (Swedbank) comprises Föreningsbanken up to Q1 1996. The series for Nordea comprises Nordbanken up to Q3 1997, Nordbanken Holding up to Q3 2000.

Sources: The banks' reports and Datastream.

TABLE 8. CHANGE IN NET INTEREST INCOME WITH A PARALLEL SHIFT IN THE YIELD CURVE (31 DECEMBER 2001)

	+ 100 points*
SEB	–
Nordea	0 MSEK
Handelsbanken	Positive
Föreningssparbanken	0 MSEK

* One year's holding period. Source: Annual reports for 2001.

The net transaction income of the Swedish banks has varied considerably from one period to another, as shown in Figure 49. However, as it comprises a relatively small part of the total income, developments in this income would not normally comprise any threat to the banks' survival.[47] The risk in net transaction income is also reflected to a large extent by the VaR values in Table 6.

Net commission income's share of total income increased in connection with the rise on the stock markets up to 2000. Since then, it has declined to some extent. Despite the severe deterioration on the stock market, the banks' total net commission income for the final quarter of 2001 was only 11 per cent lower than in the first quarter of 2000. Thus, not even the large decline on the stock market has entailed any serious threat to the major banks' earning capacity.

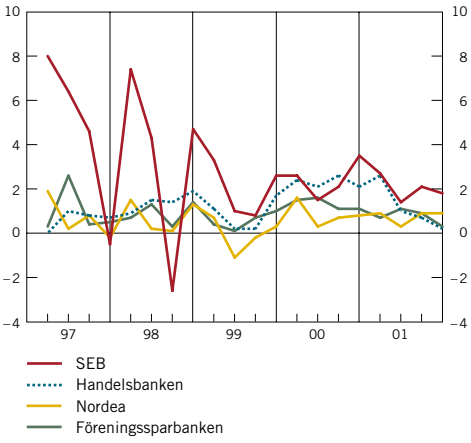
Any losses generated from net commission income are limited to the cost of running these operations. The total effect on net commission income of a weak stock market thus depends on the banks' capacity to squeeze costs. Bearing in mind the limited loss risk, net commission income is not an isolated factor that can threaten an individual bank's solvency and thus the stability of the financial system.

Conclusions

The banks' management and measurement of market risks is well developed. They regularly monitor the most important forms of market risk and have sophisticated limit systems and control systems for limiting these risks. The measuring methods used to regularly check risk levels and set limits, for instance VaR, are not intended to measure the loss risk in events that occur very rarely and do not follow previous patterns. It is probably just such a rare event that could prove a threat to the system. Measuring and identifying the risk of these requires the use of stress tests, which the banks already use to some extent.

Of all the market risks, only interest rate risk and currency risk could provide a threat to the system, as the banks have substantial exposures in these areas. However, the banks have well-developed methods for managing and reducing direct exposure to these risks and can largely choose their scope, which is also reflected in the fact that the banks' net exposures are limited. This means that they need not comprise any threat to the stability of the system. On the other

Figure 49. Net transaction income as a percentage of Tier 1 capital. Per cent



Sources: The banks' reports and the Riksbank.

hand, it is more difficult for the banks to measure and protect themselves against indirect exposure to these risks, particularly through credit risks. The relationship between the development of exchange rates and interest rates on the one side and loan losses on the other side is not something that banks currently measure or have an overall picture of.

The direct consequences of large rises or falls on the stock market are not sufficient to comprise a threat to the stability of the Swedish banking system. It is only in combination with other negative events that shocks in the stock market would be relevant from a stability point of view.

Although the exposure to market risk could be great, there is a possibility to both calculate and reduce it. In other words, the banks have good opportunities for avoiding major losses from market risk by utilising the available systems and methods.