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The Riksbank's inflation target – clarification and evaluation

By Lars Heikensten
Deputy Governor, Sveriges Riksbank

In connection with the changeover to the new law governing the Riksbank, the executive board of the Riksbank decided there was a need to clarify the formulation of monetary policy and the implementation of the Riksbank's inflation target, and to propose a means of evaluating the Riksbank's actions. This document is a summary of the proposals put forward by deputy governor Lars Heikensten at the request of the executive board, which endorsed the proposals on 4 February 1999.

The objectives of monetary policy are unchanged. However, in the interests of clarifying its policy the Riksbank intends in future to give advance warning of any possible grounds for departing from its ambition to fulfil its inflation target, as defined in terms of the CPI, within 1 to 2 years. A process is also proposed by which monetary policy could be evaluated by the Riksbank's principal and by external observers. This is particularly important in view of the increased independence of the Riksbank.

In the interests of clarifying its policy the Riksbank intends in future to give advance warning of any possible grounds for departing from its ambition to fulfil its inflation target.

The basic aim of monetary policy

According to the law governing the Riksbank, the objective of monetary policy is to maintain price stability. The adoption of this objective stemmed from the insight, in economic theory as well as from practical experience, that high inflation exacts social costs, whereas a low level of inflation provides a good foundation for economic growth.

In the light of this perception a broad political consensus in the early 1990s decided to bring inflation in Sweden down to the current European level. After being

Inflation, measured as the change in the consumer price index since 1995, was to be limited to 2 per cent, with a tolerance of ±1 percentage point.

forced to abandon its policy of fixed exchange rates in November 1992, the Riksbank chose in January 1993 to announce an inflation target for monetary policy: inflation, measured as the change in the consumer price index since 1995, was to be limited to 2 per cent, with a tolerance of ±1 percentage point. The main purpose of the tolerance interval was to indicate that deviations from the target level would probably occur and, at the same time, emphasise the Riksbank's ambition to restrict such deviations.

The level of inflation targeted by the Riksbank corresponds to that chosen by most other central banks that aim monetary policy at price stability. Another consideration was the perception that monetary policy in the European Union is directed at approximately this level. In its decision in January 1993, moreover, the Governing Board judged that the initial rate of underlying inflation would be 2 per cent.

The inflation target was formulated in terms of the consumer price index (CPI). This index was chosen mainly because it is the most familiar representation of inflation in Sweden. This was considered particularly important in establishing confidence in a new monetary policy regime. The CPI also has many other advantages: it covers a very large proportion of household consumption, is published regularly and its statistical properties are well known.

The existence of both a distinct target and a tolerance range made it clear that the Riksbank would regard unduly low inflation just as seriously as unduly high inflation.

The arrangement with a distinct target and a tolerance interval made it clear from the beginning that monetary policy's reactions to any expected deviations in inflation would be symmetric: the Riksbank would regard unduly low inflation just as seriously as unduly high inflation. A distinct target also created a good starting point for the evaluation of monetary policy.

Both the implementation of monetary policy and its analytical framework have been developed during the 6 years since inflation began to be directly targeted. In recent years the Riksbank has been more open about the motives that guide monetary policy. One example is the quarterly Inflation Report, which includes a presentation of the inflation forecast that forms the basis of the policy. The point has also been made that monetary policy is formulated for a longer-perspective: certain types of transitory and sudden shocks are allowed to affect the CPI without prompting policy adjustments. This applies, for example, to changes in indirect taxes or house-mortgage interest expenditures.

It is generally considered that having a clearly defined target for monetary policy has worked relatively well, and it has proved possible, after a couple of decades of high inflation, to establish the acceptable European level so long sought after. The expected level of inflation over the next couple of years has also during the past few years fallen to the desired level of 2 per cent. At the same time both the markets and the public have become more aware of monetary policy and its formulation. This in turn has been a contributing factor in making it easier to increase the independence of the Riksbank.

It has proved possible, after a couple of decades of high inflation, to establish the acceptable European level so long sought after.

The opinion of the executive board, as stated during the board's first meeting of the year on 4 January, is that there are currently no grounds for any fundamental changes in the formulation of the monetary policy target.

However, in the light of experience there are reasons why the formulation of policy should be clarified in some respects. This clarification involves, among other things, a more precise definition of the conditions under which a deviation from the target, as defined in terms of the CPI, is justified, and defining what should be seen in a longer perspective when formulating monetary policy. There is also a need to propose a method for evaluating monetary policy.

In the light of experience there are reasons why the formulation of policy should be clarified in some respects.

Before presenting the executive board's proposals it is worth emphasising that the work of continuously developing and improving the principles that guide the formulation and implementation of monetary policy will continue. It is, for example, possible that there may be a reappraisal of which inflation index to use as a guide for monetary policy after the CPI inquiry issues its proposals in the summer. One alternative to the CPI could be the HICP, which is being constructed under EU auspices. There may also be cause for a future assessment of monetary policy's formulation and target in the light of the move to Stage Three of EMU and the monetary policy of the European Central Bank.

Clarifying the formulation of monetary policy

It is now generally accepted that *in the long run* monetary policy has little, if any, direct effect on growth and employment. Monetary policy is, however, capable of contributing to economic stability, thereby providing a good foundation for growth and employment. This perception is indeed reflected in the Riksbank's

assignment as formulated in the amended Riksbank Act. However, it is also clear that monetary policy does have consequences for the demand situation and employment *in the short run*.

Monetary policy acts with a considerable timelag, with the largest effect on inflation in the interval of 1 to 2 years.

Even if inflation were to be clearly above or below the target, a quick return to the target (in a matter of months, for example) might be achieved with drastic interest rate adjustments. However, such a policy could result in marked and undesirable fluctuations in real economic activity. This has to do with the considerable time lag before monetary policy acts, with the largest effect on inflation in the interval of 1 to 2 years. That is one reason behind the Riksbank's decision to focus policy on fulfilling the 2 per cent target for CPI inflation during a period of just 1 to 2 years ahead. By focusing monetary policy on this horizon it is possible to limit any negative short-run effects on the real economy. Even so, there may still be reasons for also considering inflation's forecast path in the coming year as well as beyond the target horizon.

This simple policy rule needs to be clarified in two respects:

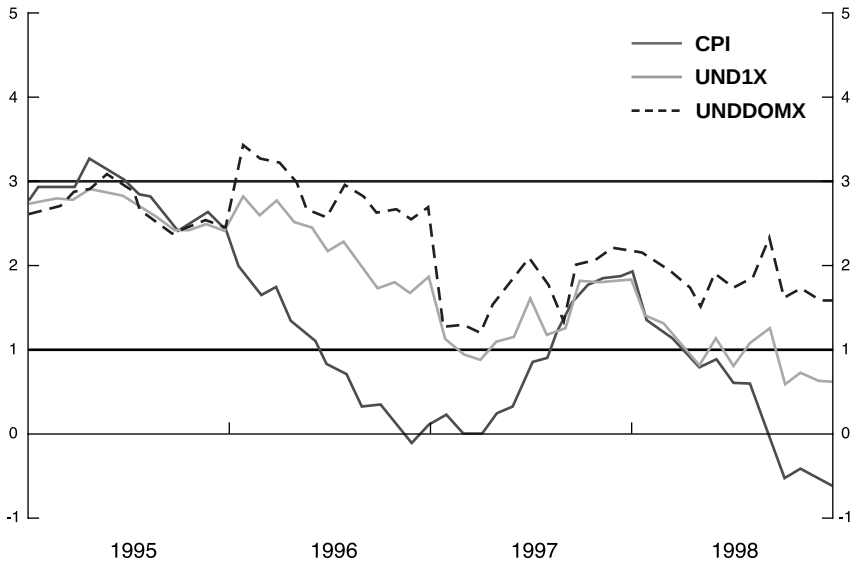
Case 1. Transitory effects

The first case covers situations in which CPI-based inflation in the relevant time perspective is being *affected by specific factors that are judged to have no substantial permanent impact* on inflation or inflationary processes. Such situations have occurred frequently in the past few years (see Diagram 1). Changes in interest rates, for example, have had considerable effect on housing costs. When long-term rates fell in 1995 and the following years, at the same time as the Riksbank started lowering repo rates from the beginning of 1996, the effect on the CPI was dramatic. On average the CPI's annual rate of increase between 1996 and 1998 was reduced by 0.7 percentage points as a result of the effect of interest rates on housing costs.

When the inflation target was presented in January 1993 it was indirectly made clear that there existed transitory effects that should not be counteracted using monetary policy. This was achieved by making the target valid for the first time from 1995 so that the CPI would have time to adjust to the effects of the weakened krona. It would of course have been possible to attempt to counter these effects faster, but the cost of doing so would have been too high for the real economy.

The Riksbank's reasoning concerning transitory effects on monetary policy

Diagram 1. CPI and underlying inflation, percentage annual change



Underlying inflation (UND1X) = CPI, excluding changes in interest costs and the direct effects of indirect taxes. Calculated monthly by Statistics Sweden.

Domestic underlying inflation (UNDDOMX) = UNDDOMX, excluding changes in import prices and the direct effects of changes in domestic indirect taxes. Calculated monthly by Statistics Sweden.

Source: Statistics Sweden

has not always been perceived as consistent. During the first few years of the inflation target some observers felt that the Riksbank concentrated too much on the CPI at the expense of the transitory effects. The lowering of VAT in 1995, it was thought, should have been partly intended to affect CPI and thereby monetary policy. During the past few years it has been made clear that there are transitory effects that the Riksbank should not attempt to counteract. Exactly when and how transitory effects have been allowed to affect monetary policy has not normally been announced in advance. For this reason it has sometimes been difficult to evaluate the Riksbank's decisions. This in turn may have been responsible for calling the Riksbank's credibility into question.

During the past few years it has been made clear that there are transitory effects that the Riksbank should not attempt to counteract.

Against this background it is not surprising that there has been a call for some sort of change or clarification. One possibility considered by the Riksbank was to abandon the index that the target was based on and adopt another index in which the transitory effects were discounted. The main problem with this is that it is difficult to find an index that works in every situation and is free of all

transitory effects. One important reason for this is that what is considered a transitory effect and what is not can vary according to, for example, how inflation expectations are affected. In reality there is no index that can easily take account of all transitory effects and be valid in all situations. Yet another possibility would, naturally, be to accept CPI-based evaluations and ignore transitory effects. This would assume that the effects are small and that any effect they have could be absorbed by the tolerance range. Perhaps the conditions for such a solution will be better in the future – now that a low-inflation regime has been established – than during the past few years when exchange rates and interest rates varied so strongly.

When it is considered that there are transitory effects that can affect the CPI, the Riksbank will in advance make it clear that a deviation from the goal is justified.

The option chosen by the executive board is different. When it is considered that there are transitory effects that can affect the CPI, the Riksbank will *in advance*, when monetary policy is being formulated, make it clear that a deviation from the goal, as defined by the CPI, is justified. There is a good reason to emphasise 'in advance': defining things when decisions are being made makes evaluation possible.

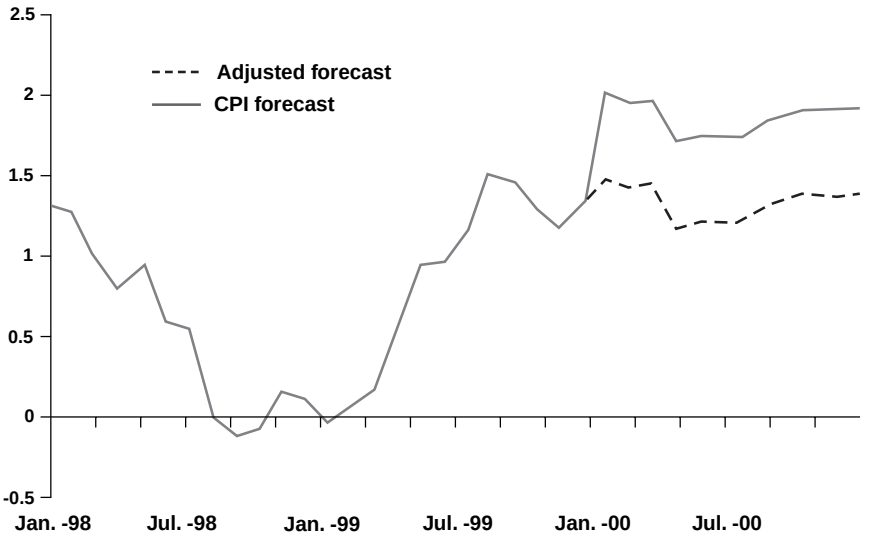
A good example of a situation of this type is to be found in the autumn of 1998. Between two consecutive Inflation Reports the Riksbank's forecast for the CPI 1 to 2 years ahead was lowered as much as 0.5 percentage points simply because of a change in the property tax for 2000 (see Diagram 2). Under these conditions an increase in the CPI to 2 per cent for a period 1 to 2 years ahead would have required substantial additional cuts in interest rates. At the same time, such cuts could have turned out to be undesirable in the longer term, when the transitory effect of frozen taxation values ceased to apply. A transitory effect of this kind on inflation should not warrant a marked repo rate cut.

Experience in Sweden and elsewhere indicates that there are three main kinds of transitory effects on inflation that should not be fully countered by monetary policy:

To try to counteract a reduction in CPI created by the direct effects of interest rate cuts with further cuts would, in terms of monetary policy, be tantamount to chasing one's own tail.

- The first type has to do with the Riksbank's own operations. A repo rate adjustment, up or down, affects *home-mortgage interest rates*, which is a sizeable component of the CPI – and has had a considerable effect on CPI. This is evidently not an effect on the CPI that the Riksbank ought to counter. To try to counteract a reduction in CPI created by the direct effects of interest rate cuts with further cuts (or vice versa) would, in

Diagram 2. Inflation forecast September 1998, adjusted for changes in property taxation



Sources: Statistics Sweden and Sveriges Riksbank

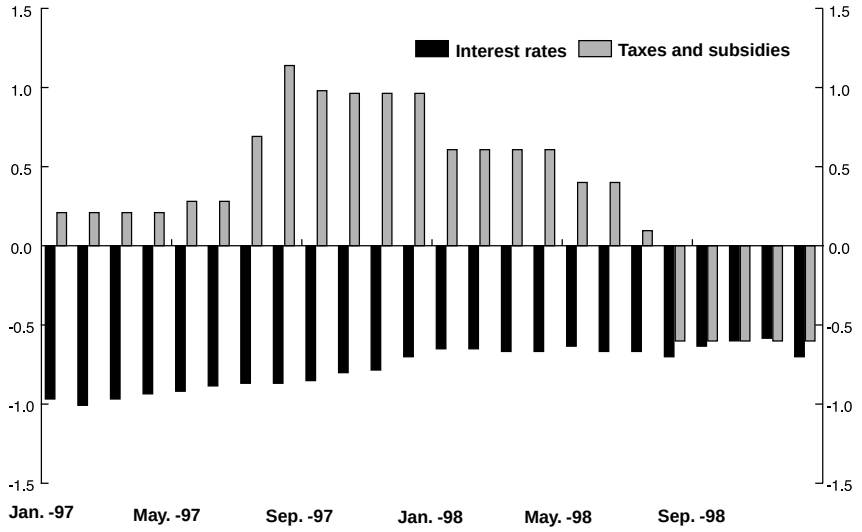
terms of monetary policy, be tantamount to chasing one's own tail.

- The monetary policy effects of *indirect taxes and subsidies*, which have also played a substantial role in the past few years, can be analysed in a similar way (see Diagram 3). If the effects on inflation from existing or proposed changes to taxes and subsidies are judged to be transitory, monetary policy ought not to be formulated to counter them. Moreover, in the same way as with a repo rate adjustment's effect on interest rates, there is a link here with economic policy. An increase in the VAT rate, for example, may have been made to subdue demand and curb future inflation.
- Similar problems may arise in connection with *supply shocks*. Price movements for petroleum and other imported goods, for example, that are judged to have only transitory effects on domestic inflation ought not to elicit monetary policy countermeasures.

Supply shocks may need to be analysed particularly closely and cited selectively as an argument for departing from the CPI target.

It should be emphasised that the question of what constitutes a transitory effect is *complex*. In many instances there is no simple answer and, even if clarity is the aim, the fact remains that the assessments are difficult. This is particularly evident in the case of supply shocks. To what extent do import price movements, for example, reflect transitory factors rather than the more

Diagram 3. Transitory effects. Contribution to annual changes in CPI



Source: Sveriges Riksbank.

long-term consequences of international competition? Attempts to answer questions like this soon become reminiscent of the debate in, for example, the USA during the 1990s that, because of advances in technology, global competition, and so on, function differently from an inflation point of view than they did previously. Although there may be reason to be sceptical of the view that such effects may continue forever, the question remains: How long can these effects influence events? Events that span a decade or more can hardly be considered as transitory. This suggests that supply shocks may need to be analysed particularly closely and cited selectively as an argument for departing from the CPI target.

In any assessment of whether or not an inflationary shock is transitory, a central question is the impact on inflation expectations. Take, for example, an increase to an indirect tax that is judged to elicit higher wage demands and thereby affect the inflation process. This is what happened in the 1970s and 1980s, when prices and wages chased one another. Under these conditions there was a substantial risk that tax increases would have much more than just a transitory effect on inflation. If inflation expectations are influenced, the impact of what would otherwise be a transitory shock can thus be permanent, in which case the shock should be allowed for in the formulation of monetary policy.

Case 2. Handling deviations from the target

The other case is when *inflation for some reason has deviated markedly from the target.* This raises the question of *how quickly* inflation should be returned to the target rate of 2 per cent. It is envisaged that, on average, the Riksbank should deploy its measures with a view to returning to the target in the course of the coming 1 to 2 years. But the size of the necessary interest rate adjustment and the period over which it should be implemented are matters that will have to be decided from case to case. A mechanical approach that invariably attempts to bring inflation back to the targeted level within the next 1 to 2 years could lead in certain cases to unduly large and undesirable fluctuations in economic activity. The Riksbank's discretion in this respect is partly dependent on the credibility of economic policy. Strong confidence in the commitment of monetary policy to long-term price stability, together with a credible economic policy in other respects, can enlarge the scope for flexibility in the policy's short-run formulation.

Strong confidence in the commitment of monetary policy to long-term price stability, together with a credible economic policy in other respects, can enlarge the scope for flexibility in the policy's short-run formulation.

In the past few years inflation has to a large extent been under the target level. This has meant that the Riksbank has not had to concern itself with questions such as how quickly it should attempt to bring down high-level inflation. The problem has been quite the reverse. Inflation has been under 2 per cent also after transitory effects been taken into account. On several occasions when decisions were taken, credibility played some part in determining policy. One of these occasions was spring 1996, when the repo rate was quickly lowered, albeit in small steps, to avoid, among other things, a negative reaction against the exchange rate, which in turn could distort the inflation trend.

The conclusion from the discussion above is that the simple rule for monetary policy decisions – adjust policy so that the 2 per cent target for the CPI is fulfilled in 1 to 2 years – may need to be clarified in two respects. One is that the Riksbank may be justified in not concentrating on attaining a CPI increase of 2 per cent if it considers that inflation is being influenced by transitory effects. The other is that in the event of a considerable shock, there may be grounds for not attempting to return inflation to the targeted level immediately. In such a situation the Riksbank shall clearly state *in advance* – in the Inflation Report and in connection with monetary policy decisions – how it expects inflation to deviate from the target and why. In both cases the justification for deviations are the

social costs that might otherwise be incurred because of avoidable fluctuations in economic activity.

The Riksbank shall continue along the same path as before but increase the clarity of its policy.

Finally it should be emphasised that these clarifications do not represent any change in the fundamental direction of monetary policy. The Riksbank is to continue along the same path as before but increase the clarity of its policy.

Evaluating target fulfilment

To maintain the credibility of monetary policy and its support in society it is important that the policy is widely understood, openly discussed and evaluated. The Riksbank's new independence has further reinforced this need.

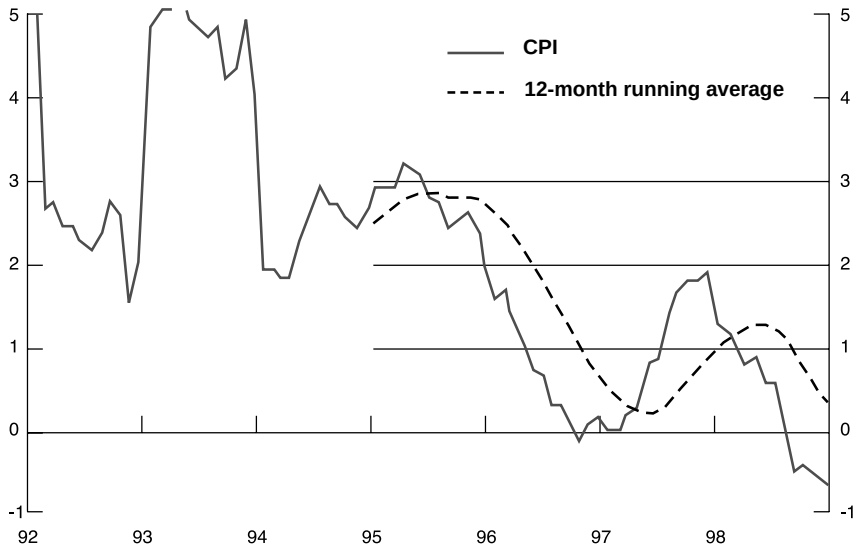
To enable evaluation the policy must be characterised by openness, and the Riksbank needs to be explicit.

To enable evaluation the policy must be characterised by openness, and the Riksbank needs to be explicit. It will then be easier to assess new information and predict how the Riksbank will act. Monetary policy can accordingly contribute to less uncertainty in financial markets and the economy in general. It is particularly important that the Riksbank provides clear information to its principal, the Riksdag. The governing board of the Riksbank acts as an important intermediary between the executive board and the Riksdag. A good supply of information is essential for the Riksdag to understand the reasoning behind the Riksbank's monetary policy and evaluate its actions.

A good supply of information is essential for the Riksdag's evaluation of the Riksbank's operations.

The Riksbank is required to make a written report on monetary policy to the parliamentary standing committee on finance at least twice a year. The Riksbank considers that these reports should coincide with its governor's appearance before the standing committee. In connection with the first appearance each year the Riksbank intends to account for the results of its policy. The material that is presented should include a comparison between the 2 per cent target for CPI inflation and the outturn. The above-mentioned clarifications are crucial here as they make it easier to determine whether deviations from the target are attributable to earlier decisions rather than to other factors, for example, forecasting errors. The outturn for inflation is to be presented both as consecutive 12-monthly figures and as the running average of these figures. Such statistics have already appeared in the latest inflation reports (see Diagram 4).

Diagram 4. Consumer price index. Annual percentage change and 12-month running average



Sources: Statistics Sweden and Sveriges Riksbank.

When material that will form the basis of an evaluation is being prepared for presentation, there are many factors that need to be taken into consideration to ensure that this is as thorough as possible. Such factors include the Riksbank's reasons for any decisions taken in regard to motivated deviations from the target, as well as any genuinely new information that appears between a decision being made and the completion of an evaluation. This category of information could also include views on inflation from outside observers. Other questions that may arise concern whether a deviation from the target is the result of a misinterpretation of the overall picture of inflation, or whether the deviation is based on the effects of the policy proving to be different from expectations. The exact nature of the material that is produced to elucidate the consequences of monetary policy will naturally depend on, among other things, the wishes of the Riksdag. A gradual development over time with increasingly in-depth analyses seems the most probable outcome.

The exact nature of the material that is produced to elucidate the consequences of monetary policy will naturally depend on, among other things, the wishes of the Riksdag.

In this context the tolerance range will have an operational function. Whenever CPI inflation is outside the tolerance range, the

The tolerance range will have an operational function.

Riksbank is to present an explanation of the background to this. These explanations will serve, for instance, to highlight the transitory effects that are judged to have been acting and that the Riksbank took into account in the formulation of monetary policy. In this context, moreover, the Riksbank can show how target fulfilment has been affected by the rate at which inflation has been brought back to the target after a shock. Explanations of this kind can provide the Riksbank's principal with a foundation for evaluating the Riksbank's forecasting ability and conduct of monetary policy.

The Riksbank will, as before, use the Inflation Report to present the current path of inflation as well as the Riksbank's inflation forecasts in relation to the targeted rate and the tolerance range.

Summary

This article discusses how monetary policy can be made clearer in the future and how it can be evaluated. The decision to do this was taken by the executive board of the Riksbank on 4 January 1999. The proposals do not contain any changes to the basic aims of monetary policy or the way in which monetary policy is formulated.

Monetary policy is normally conducted so as to be on target, defined in terms of the CPI one to two years ahead. Departures from this general rule may be warranted for two reasons. One is that the CPI can be pushed upwards or downwards in the relevant time perspective by one or more factors that are not considered to affect inflation more permanently. Changes in interest expenditure, indirect taxes and subsidies are examples of such factors. The other reason for departing from the rule can be that a quick return to the target in the event of a sizeable deviation can sometimes be costly for the real economy. In the event of either of these situations occurring, the magnitude of the deviation from the inflation target, defined in terms of the CPI, that may be motivated 1 to 2 years ahead, will be clarified by the Riksbank *in advance*.

An account of the policy outturn will be presented regularly by the Riksbank in connection with the Governor's first appearance each year before the Parliamentary Standing Committee on Finance.

Facilitating an evaluation of monetary policy is particularly important in view of the Riksbank's increased independence from 1999. Clarification along these lines will simplify *backward-looking* assessments of monetary policy. It will become easier to distinguish the extent to which deviations from the target are a consequence of deliberate decisions made when formulating the policy. An

account of the policy outturn will be presented regularly by the Riksbank in connection with the Governor's first appearance each year before the Parliamentary Standing Committee on Finance. The account will be based on the path of the CPI, measured both as consecutive 12-monthly figures and as the running average of these figures. If the CPI changes have moved outside the tolerance range, the reasons for this will be explained, taking into account any factors that had been identified in advance.

Hedge funds – trouble-makers?

By Per Walter and Pär Krause
Per Walter, Monetary and Exchange Rate Policy Departement and Pär Krause, Payment Systems Department, Sveriges Riksbank

Last autumn's turbulence in global financial markets was accentuated by the instability spread by the near collapse of Long-Term Capital Management (LTCM). The huge losses of this hedge fund in the wake of Russia's August 1998 international payments suspension and the subsequent capital flight from emerging and other markets caused both market players and the Federal Reserve to worry about the consequences of an uncontrolled unwinding of outstanding positions. In practice, only systemic risks related to a financial market failure justify the intervention of a central bank. In this context, there are many indications that the problems were mainly due to inadequate risk monitoring by banks.

Seemingly generous lending to hedge funds by banks have caused many observers to advocate more stringent regulations.

The now almost legendary hedge funds have been into the spotlight since the autumn 1998 financial market upheaval. Huge losses by the hedge fund Long-Term Capital Management (LTCM) and seemingly generous lending to hedge funds by banks have caused many observers to advocate regulation to overcome these problems. But what is the fundamental problem? What is a hedge fund? What was behind the collapse of LTCM? What can central banks and other public authorities do to prevent a recurrence of systemic risk? The purpose of this article is to answer these questions, within the limits of this article, to the greatest possible extent.

The article is organised as follows: first it provides a schematic picture of hedge funds in general, followed by a recapitulation of the autumn 1998 financial turbulence, with emphasis on problems related to LTCM. It then discusses in detail why the payments system was threatened by so-called systemic risk, as well as possible reasons for this development. Finally, it briefly discusses the policy implications and arguments for greater official regulation of hedge funds and banks.

Hedge funds – an overview

What is a hedge fund? There is no simple, uniform definition of the hedge fund concept. The investment strategies of these funds vary sharply. Hedge funds nevertheless have many characteristics in common.

- **The formal structure of these companies** is often a *limited partnership*, with the number of partners not exceeding 100. General partners are responsible for the day-to-day management. The obligations of limited partners are restricted to their invested capital and they have no direct influence on management. Unlike other types of funds, managers risk their own money in the company. This is one reason why hedge funds often focus on optimising return and risk in absolute terms, and not like other funds in relation to a comparative index (benchmarking). Their structure thus helps give managers a powerful incentive to monitor risk/return, which is reinforced by high return-related fees (often up to 20 per cent of return).[1]
- **Limited official supervision and extensive freedom.** Around half of all hedge funds have the United States as their country of origin, but due to American legislation many funds are registered in countries with a less extensive regulatory system and an absence of official supervision – among them the Cayman Islands and Bermuda. In the United States, for example, a fund with more than 100 partners is under the supervision of the Securities and Exchange Commission (SEC). This is not the case with offshore funds, which can ordinarily have an unlimited number of partners (open ended funds) or in American funds structured as limited partnerships. Limited official supervision helps provide extensive freedom when it comes to risk-taking and investment strategies typical of hedge funds. Managers also have greater freedom of choice since partners often commit their capital for a long period, sometimes several years. Swedish hedge funds – such as ZENIT and NEKTAR – are, however, under the jurisdiction of the Financial Supervisory Authority.[2]
- **Limited transparency.** Hedge funds are secret by nature. Often only a

[1] However, because of profit-related management fees, all else being equal, a manager does not share the losses of other partners in case of a negative return. This asymmetry may provide incentives for greater risk-taking, which is nevertheless offset by the fact that managers have invested their own capital in the fund.

[2] In 1994, a change in legislation introduced the concept of national funds and made it possible to establish a Swedish hedge fund. The legal framework and main criteria for investment rules etc. are the same as for other securities companies, but via licences from the Financial Supervision Authority, a hedge fund may deviate from these rules in specified respects. The prerequisite is that they aim only at professional investors and do not market their products to the broad general public. Certain risk limitations have been formally imposed, and the portfolio must be reported openly on a quarterly basis. The Financial Supervisory Authority is also entitled to make on-the-spot inspections without prior notice.

small circle of managers are familiar with the portfolio's total exposure and contents. Partners and lenders often have to accept very sketchy information. The limited official supervision enjoyed by most hedge funds facilitates this secretiveness. Research in this field is naturally also made more difficult by the limited amount of public information.[3]

- **Not for small investors.** The minimum investment is often one million dollars. Hedge fund investors are often wealthy private individuals, although institutional investors have become more common as partners in recent years.

Varying investment strategies

Although the investment strategies of hedge funds vary considerably two main categories are discernible.

Although the investment strategies of hedge funds vary greatly, in our opinion two main categories are discernible. The first can be labelled archetypal, traditional hedge funds. For example, such a fund combines sales (a short position) and purchases (a long position) in an asset that is under- or overvalued, respectively, and seeks a return that is independent of overall market developments. Put simply, the fund is thus protected against "market risk", since a general price fall helps the changes in the value of long and short positions offset each other. Thus the name "hedge" fund, since hedging means protection. Returns and risks originate from the price difference between assets and the leveraging effect that may be achieved via loan financing and derivatives (see, for example, pages 27–29). LTCM belongs to this category of hedge funds.

The other main category of hedge funds takes speculative positions based on assessments of the price trend of individual assets (for example shares of a company threatened by bankruptcy) or of a market as a whole (for example a general stock market decline). These funds thus often analyse major changes in the global economy as well as micro-economic conditions in detail. The point is that these funds do not systematically protect themselves ("hedge") against all other risks. Consequently these funds can hardly be called hedge funds in the traditional sense. Instead, they are funds that utilise the typical company structure of a hedge fund and its extensive freedom for purely speculative purposes. The box below presents a classification of various types of hedge funds and their investment strategy.

To achieve the desired exposure, hedge funds use a variety of financial instruments in virtually all markets: foreign exchange, fixed-interest and equity

[3] There are nevertheless a few institutions that continuously monitor developments among hedge funds. Examples of these are MAR/Hedge, Van Hedge Fund Advisors, TASS and Financial Risk Management Limited.

markets. For example, by utilising a derivative – an instrument in which agreement is reached today on the future price of an asset – the risk profile of investments can be refined by selling certain risks and keeping others.

Hedge funds operate globally. In recent years, they have been very active in the "new" markets of Russia, Asia and South America. Hedge funds became well known earlier, however, for instance through currency speculation during the European Exchange Rate Mechanism (ERM) crisis of 1992 and the Mexican crisis of 1994–95. They are well known for convergence trading in interest rates on government bonds in the run-up to the Economic and Monetary Union (EMU) and in connection with the fall of the Thai currency in July 1997.

Different types of hedge funds[4]

Market Neutral
Funds that operate in essentially all types of financial markets and that try to take advantage of temporary "pricing anomalies". Return is thus largely independent of the direction of market developments. This is the archetypal hedge fund in the traditional sense.

Macro
Funds that speculate in global changes at the macro level which are reflected in interest rates, currencies and equities. They take positions in direct market developments and attempt to maximise return via the "leveraging effect" that can be achieved via loan-financed investments and derivatives.

Global
Like *Macro* but more focused on developing markets and other specific regions of the world.

Event-driven
Funds that speculate in specific events – corporate mergers, bankruptcies etc – and that take positions based on these speculations.

Long only
Traditional equity mutual funds, structured like hedge funds (working with loan-financed holdings for their long positions).

Dedicated short-sellers
Funds that take short positions in securities, borrowing securities and selling them immediately in the hope of buying them back at a lower price and thereby earning money when prices fall.

Sectorial
Funds that take positions in equities based on an industry perspective.

Funds of funds
Funds that invest their portfolios in other hedge funds. The minimum investments in these funds are very high, often more than one million dollars.

[4] This classification is taken from MAR/Hedge, a company that continuously publishes facts about hedge funds. Other classifications exist.

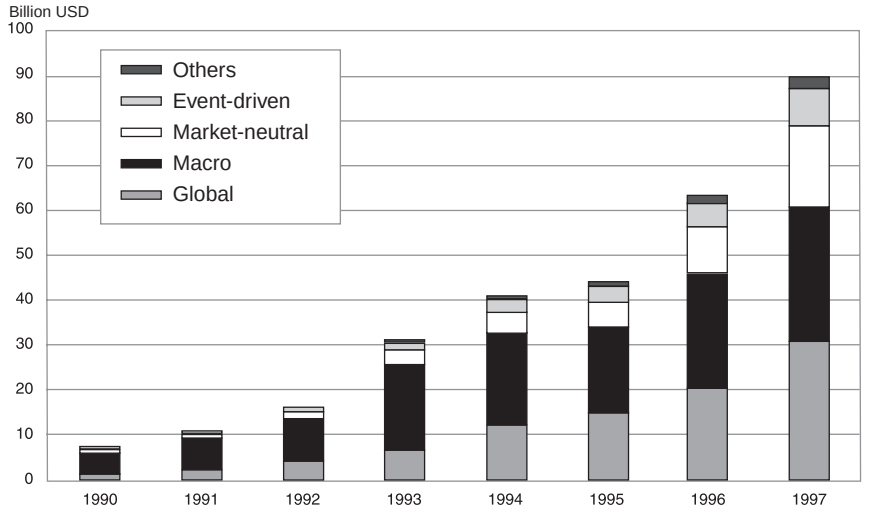
Hedge funds – a growing industry

Today there are about 3,000–5,000 hedge funds, managing assets equivalent to about 100–400 billion dollars.

Since access to information about hedge funds is very limited and uncertain, figures on the size of the hedge fund industry vary greatly. One thing is certain, however: the operations of hedge funds have grown very rapidly in recent years. Today there are about 3,000–5,000 hedge funds, managing assets equivalent to about 100–400 billion dollars. By way of comparison, in the early 1990s there were only about one hundred hedge funds, with about 10 billion dollars under management. As Chart 1 indicates, the assets invested in hedge funds have grown sharply during the 1990s. The *macro, global* and *market neutral* categories dominate, accounting for about 90 per cent of total managed assets in 1997.[5]

The *macro* category includes George Soros' well-known Quantum Fund and Robertson's Tiger Management, which as of 1998 reportedly managed around 30 billion dollars.[6] Aside from a handful of major funds, however, most hedge funds are small. About 50 per cent of hedge funds each manage less than 100 million dollars.[7] Relative to dominant investor vehicles in the global financial markets, hedge funds also manage only a small fraction of total savings.

Chart 1. Managed assets* by type of hedge fund, 1990–97



Source: MAR/Hedge. At the end of each year.

[5] MAR/Hedge, exclusive fund of funds.
[6] Steinberger, *Euromoney*, August 1998.
[7] TASS, P. Cottier.

Partly due to their lack of transparency as well as rumours of highly leveraged speculation strategies, hedge funds have often been singled out as scapegoats at times of dramatic events in financial markets. They are blamed for having profited from and having caused – or at least aggravated – such events as the October 1987 stock market crash and the fall of the Thai baht in 1997, to give two examples. However, to date it has been difficult to prove that hedge funds have de facto profited from or caused these events, as evidenced by studies published in 1998 by the International Monetary Fund and the National Bureau of Economic Research,[8] among others. It is difficult to find empirical support for the thesis that hedge funds in general can systematically drive markets and take advantage of investors' herd instincts. Furthermore, the fact that Soros' hedge fund made large profits in connection with the fall of the British pound in 1992 does not necessarily mean that the actions of this fund made the currency fall.

It is difficult to find empirical support for the thesis that hedge funds in general can systematically drive markets and take advantage of investors' herd instincts.

Another widespread perception is, as indicated, that hedge funds are generally more risky and more highly leveraged than other funds and financial players. However, there is some evidence that creates a more nuanced picture (see box on page 24).

The rise and fall of LTCM

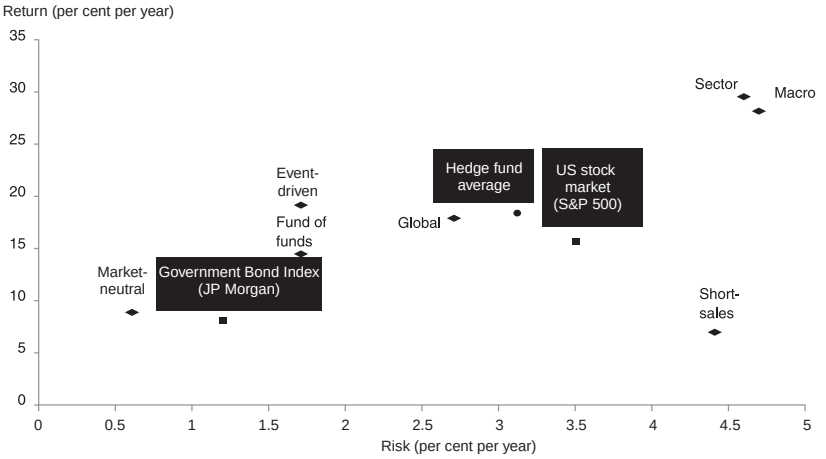
The hedge fund known as Long-Term Capital Management (LTCM) was founded in 1994, among others by the well-known financial strategist John Meriwether. The fund established a registered office in the United States (Greenwich, Connecticut) and avoided government supervision by means of its company structure (limited partnership). Wealthy private individuals who invested in the fund had to commit their capital for a long period and meanwhile accept not being informed of LTCM's risk exposure. LTCM characterised itself as a fund of the "market neutral" type. One element of LTCM's mission was to attempt to utilise statistical/mathematical models to find "pricing anomalies" between assets – primarily in fixed-rate markets – and exploit these with the help of financial derivatives and leveraged invest-

One key element of LTCM's business concept was to utilise statistical/mathematical models to find "pricing anomalies" between assets.

[8] See Chadha, B. & Jansen, A. (May 1998), IMF, as well as Brown, Goetzmann & Park (February 1998), NBER.

Risk and return – a surprise?

One common perception is that return, but also risks, are substantially higher for hedge funds than for other financial investments such as equity mutual funds, individual equities or fixed-rate investments. However, the chart below indicates that during the period 1990–97, the American stock market was more risky (measured as annualised volatility) than most hedge funds, including the average hedge fund. Yet the average annual yield of most hedge funds has been higher. In other words, this indicates that hedge funds in general have managed assets well. All types of hedge funds – except *short sellers* – have had higher risk-adjusted return (return/risk) than the US stock market during the period in question.



Source: MAR/Hedge. Hedge funds do not include Long only and Fund of funds. There are no details for Long only, but this category represents less than 1 per cent of the total amount invested in hedge funds.

Statistics can be misleading, however. Investment strategies and the earnings trend show relatively wide variations within each hedge fund category, with low correlation as a consequence. The risk in an individual hedge fund may thus be very large (the case of LTCM is a good example of this). The low correlation within each category, combined with the fact that hedge funds in general show low correlation with traditional investments, are factors that enable portfolio managers to utilise investments in hedge funds for diversification purposes.

One contributing reason why hedge funds in general are not as risky as often claimed may be that the scale of leveraged investments is exaggerated. According to Van Hedge Fund Advisors, a research institution, about 30 per cent of hedge funds do not use leveraged investments at all, 54 per cent have a debt ratio (liabilities/equity) of less than 2, and leveraging of 10 times is very rare.[9] By way of comparison, leveraging of 20 or higher is reportedly common in investment banks' own portfolio investments. In August 1998, LTCM reportedly had leveraged investments a full 50 times larger than its equity. This indicates that LTCM took extremely large risks. Leverage – liabilities divided by equity in the balance sheet – is nevertheless a crude yardstick of portfolio risk, since it does not take into account off-balance sheet positions (derivatives) that may operate in a risk-reducing direction.

[9] See *Statement to Members of Congress (USA)* by S.A. Londsdorf, VHA President (October 1, 1998).

ments in securities. This strategy was probably facilitated by the expertise contributed by the 1997 Nobel laureates in economics – Myron Scholes[10] and Robert Merton. In 1995 and 1996 the fund (after subtracting management fees) yielded a return of more than 40 per cent annually – considerably higher than the American stock market – and its reputation for success spread.[11]

What made the tide turn?

During 1998, LTCM reportedly speculated mainly in interest rate differentials between the bond markets in the United States, Europe and Japan. The sustaining concept was expectations that "abnormally" large interest rate differentials would narrow between bonds carrying different liquidity and credit risks, for example between mortgage, corporate and government bonds. In 1998, the market trend went against LTCM, however (see examples in the box below). In the wake of the Asian crisis and the summer's stock market decline, financial market players became increasingly cautious. The Russian devaluation and the moratorium on portions of Russian foreign debt on August 17 contributed to major losses for several players and marked the beginning of a downward trend in financial markets. The need to sell assets to cover losses generally increased. Together with great risk aversion among investors, this contributed to rising liquidity and credit risk premiums on world fixed-interest markets, as well as massive capital flight from emerging markets and other risky investments. During this period of instability, only certain bonds, for example 10-year American and German government bonds, were considered safe. Escalating demand caused interest rates on these bonds to fall sharply. "Flight to quality and liquidity" was the dominant theme in financial markets and spelled doom for LTCM.

"Flight to quality and liquidity" was the dominant theme in financial markets and spelled doom for LTCM.

[10] Together with Black, Scholes developed the Black & Scholes model for option pricing, which today is still the model that most market players use.

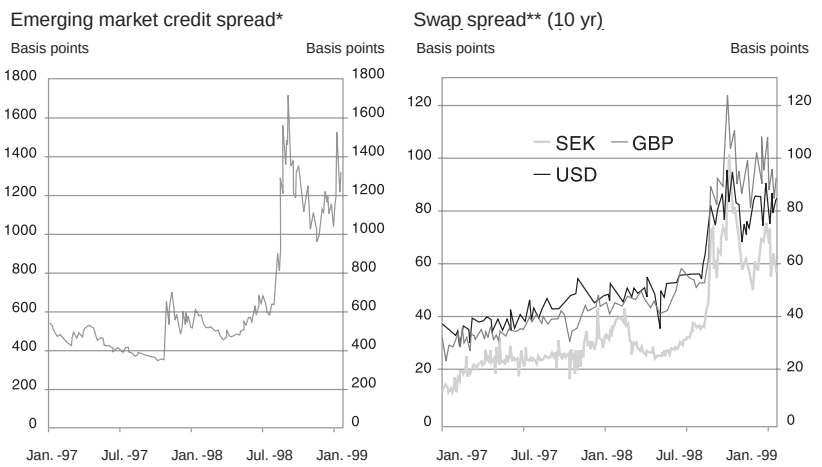
[11] By way of comparison, the return on the S&P 500 was 35 per cent in 1995 (LTCM 43 per cent) and 20 per cent in 1996 (LTCM 41 per cent).

LTCM – a practical example

What did LTCM do? Aided by loan-financed investments in securities and financial derivatives, LTCM used limited equity to speculate in narrower interest rate differentials in the bond market. Most of these positions were reportedly quite simple in structure, rather than complex combinations of options or the like. Put simply, LTCM's strategy can be illustrated by saying that the fund took long forward positions (which rise in value when the price climbs) in more risky assets judged to be undervalued, for example American corporate or mortgage bonds.

What had LTCM speculated in?

Among other things, LTCM had speculated in a convergence between American government bonds with different benchmark status – on-the-runs (benchmark) and off-the-runs (non-benchmark) – with a liquidity risk-related interest rate differential despite essentially the same maturity.[12] Like most other hedge funds, LTCM also reportedly bet on narrower interest rate differentials – "credit spreads" – between U.S. government bonds and dollar-denominated government bonds issued by developing countries (among them Russia).[13] LTCM supposedly spiced its portfolio with option positions reflecting expectations that stock market volatility was exaggerated and would decline.[14] LTCM's speculations went totally against the trend noted in the world's financial markets during the summer and autumn of 1998, with wider interest rate differentials plus greater volatility and generally poorer liquidity as a consequence (see chart below).



Source: ECOWIN

*The difference in interest rate between a weighted government bond rate (bonds denominated in USD) for emerging markets and American long-term bond yields. The developing countries included are Argentina, Brazil, Bulgaria, Ecuador, Mexico, Panama, Peru, Poland, Russia and Venezuela.

** A swap spread is the difference between fixed interest in an interest-rate swap and the government bond yield for the same maturity. It provides a rough estimate of market pricing of the credit risk differential between private and state sectors.

At the same time, it took short forward positions (which rise in value when the price falls) in assets judged to be overvalued relative to the former assets, for example American government bonds. The total position (long plus short) rises in value if the interest rate differential narrows and falls in value if the differential widens. On the other hand, the total position is protected against *general* interest rate movements – market risk – when forward assets and forward liabilities are equally large.[15] Risk and return thus relate exclusively to the interest rate differential.

LTCM used the repo market to achieve these positions with little capital investment. Below is a somewhat simplified example of how this may have occurred.

LTCM used the repo market to achieve their positions with little capital investment.

Long position in mortgage bonds (see figure)

LTCM buys a mortgage bond in the spot market. It finances the payment via a short-term bank loan. The fund then gives the bond to the bank as security for the loan. In purely formal terms, the fund sells the bond to the bank with an agreement to repurchase the security at a predetermined price (a repo[16]). The hedge fund thus invests no capital.

When the loan, that is the repo, falls due (a common maturity in the repo market is two or three days[17]) the opposite occurs: the fund repays the loan and gets the collateral back (repurchases the mortgage bond). At the same time, it sells the bond in the market. The payment that the fund receives for the bond is what enables it to pay the bank loan (these transactions thus occur simultaneously). If

[12] Bonds with benchmark status (on-the-run) are included in bond indexes that several investors use. When a bond falls out of the index (off-the-run), trading and thus liquidity therefore often diminish.

[13] These investments probably only comprised a small portion of the portfolio, however. According to LTCM's own information to its investors in September, only about 16 per cent of the fund's losses were directly related to emerging markets.

[14] This position can be achieved, for example, by issuing a "straddle" where call and put options are issued on equity indexes with the same redemption price and maturity. Simply put, the market player has thereby "sold volatility" and taken a short position that will be profitable if future actual volatility is lower than the market's average expectations.

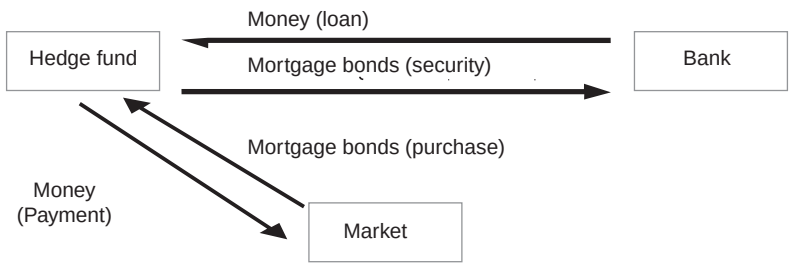
[15] This is true provided that bond prices react exactly alike to general interest rate movements, which requires that the bonds have the same duration (and convexity).

[16] A repo is defined as a spot market sale of securities (today) combined with a forward (future) purchase, which implies an obligation to implement the purchase at a price determined today. Since the spot and forward prices are known in advance, the interest can easily be calculated on the money that the market player is borrowing de facto. The transaction can thus also be viewed as a time-limited loan with collateral, where one player borrows money today and provides a bond as collateral. When the loan falls due, repayment including interest occurs at the same time as the collateral is returned.

[17] In practice, repos are continuously renewed ("rolled over"), which means that, in reality, the maturity is longer.

Long forward position in mortgage bonds

Figure relates to spot transactions



SUMMARY

* Purchase spot in market (long position)
* Sell spot to bank (short position)
* Repurchase agreement with bank (long position), that is, a forward purchase (not shown in figure)

Net: LONG FORWARD POSITION

the mortgage bond has fallen (the price has risen) during the life of the repo, the fund thus receives a higher spot market price than it paid a few days earlier. If this market profit exceeds the repo interest that the hedge fund pays to the bank, the fund has made a profit on its long mortgage bond position.

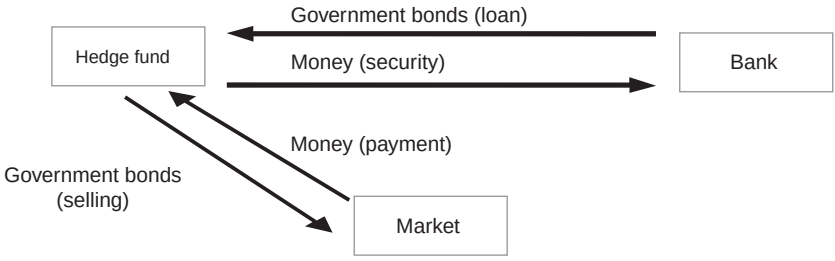
Short position in government bonds (see figure)

LTCM borrows a government bond from the bank and puts money in the bank as collateral; in other words it buys a bond with an agreement to resell it at a predetermined price (a reverse repo). The deposit in the bank, that is the collateral, is financed via a spot market sale of the government bond. Thus the hedge fund makes no capital investment.

When the loan (reverse repo) falls due, the hedge fund returns the government bond to the bank, that is, resells it to the bank. The bond that is sold to the bank is thus bought in the spot market. The purchase is financed by the money that the fund gets back from the bank. If the government bond yield has risen (the price has fallen) during the life of the reverse repo, the market price that the fund pays for the bond is lower than what the fund paid the bank for the bond a few days earlier. The hedge fund thus makes a profit on its short position in government bonds.

Short forward position in government bonds

Figure relates to spot transactions



SUMMARY
* Sell spot in market (short position)
* Purchase spot from bank (long position)
* Repurchase agreement with bank (short position), that is, a forward sale (not shown in figure)

Net: SHORT FORWARD POSITION

The risk is related to the interest rate differential[18]

Large losses can occur despite insurance against market risk, losses that must be covered by equity.

Forward positions yield a large risk/chance (return) in terms of the growth in the interest rate differential per own krona invested (here zero) – that is, they generate powerful leverage. The reason is that a position was achieved without a capital investment. A narrower interest rate differential yields a high return on invested capital. However, leveraging quickly results in large losses in case of a wider interest rate differential (for example as a result of flight to quality and liquidity). Large losses can thereby occur despite the fact that the fund insured itself against market risk – these losses must be covered in some way, for example by equity. The fundamental problem is thus that the hedge fund can rapidly build up very large risks and quickly lose its equity. The threat of bankruptcy can thereby materialise very quickly, even though new loans may prolong the process.

Banks require extra collateral. In practice, a small capital investment is initially required, compared to the example. In case of financial failure, the bank that received

[18] If the bond is held until maturity, the hedge fund receives a fairly safe return. Simply put, this locks in the interest rate differential between the bonds. This return can be regarded as a substitute for credit risk, since the probability that the mortgage institution will fail is regarded as higher than the probability that the state will do so.

mortgage bonds as collateral for a loan to a hedge fund runs the risk that the collateral will no longer cover its lending. To protect itself against this, the bank will, for example, require mortgage bonds valued at SEK 105 as collateral in order to allow the counterparty to initially borrow SEK 100. In other words, it applies a 5 per cent *haircut*. If the mortgage bonds should fall by more than 5 per cent, the bank may react by demanding further collateral, known as a *margin call*, to compensate itself for the greater credit risk. If this obligation is not met, the bank (depending on the structure of the contract) is entitled to sell the collateral (the mortgage bonds) to cover the credit risk that has arisen. The bank's internally established counterparty limits may then force the suspension of all further transactions with the hedge fund. As a last resort, the bank can force the fund into bankruptcy.

Some claim that LTCM tried to give each bank the impression that it was an exclusive counterpart.

In their competition for status clients like LTCM, the banks reportedly granted the fund very generous haircut and margin call terms. There were also very generous counterparty limits and unsecured lending. Since they had no way to keep track of the fund's risk-taking, the banks were also unable to monitor the very large risk exposure that LTCM built up by using numerous banks. Some people claim that LTCM tried to give each bank the impression that it was an exclusive counterparty. Some banks were perhaps thereby fooled into believing that at least they had a fairly clear picture of LTCM's total risk exposure.

The collapse of LTCM

September 2, 1998, LTCM informed its partners that the value of the fund had fallen by no less than 44 per cent in August and by 52 per cent thus far during 1998.

Since market trends moved in the wrong direction, from LTCM's perspective, and interest rate differentials widened, the value of the fund's total position fell. LTCM thus became insolvent relatively quickly, since its chances of covering large losses with limited equity were small. In a letter dated September 2, 1998, LTCM informed its partners that the value of the fund had fallen by no less than 44 per cent in August and by 52 per cent thus far during 1998. Rumours and alarm now spread like wildfire in the market. LTCM's gigantic positions, comparatively extreme risk-taking (see box on page 24) and potential impact on prices if it withdrew from the market helped to fuel uncertainty and volatility as well as a herd mentality in financial markets. According to a rough estimate in the magazine *Risk*, LTCM had positions tied to the interest rate swap market equivalent to 1,250 billion dollars, or about 5 per cent of the global market.

The mere *rumour* that LTCM had a position in a given market created instability and caused market players to unwind their positions, with a further widening of interest rate differentials in most fixed-interest markets among the consequences. In a generally unstable financial market climate, with growing risk aversion and mounting risks, most market players probably chose certainty before uncertainty and elected not to wait for reliable information. This may be one reason why swap spreads increased sharply in most fixed-interest markets in the autumn of 1998 (see chart on page 26). This instability was reinforced by fears about how the banks would react to LTCM's problems.

The value of mortgage and corporate bonds (and other more risky securities) fell and was expected to continue falling sharply. As indicated, banks make margin calls when the value of a bond no longer covers lending and a credit risk thus arises. These requirements became increasingly difficult for LTCM to meet. The fund therefore found itself in an acute liquidity crisis that presumably would quickly force the fund to use its equity to meet obligations. If banks thus receive no extra collateral for their repo transactions, they may (depending on the structure of the contract) be entitled to sell the existing collateral, albeit perhaps with a loan loss if the mortgage or corporate bonds etc have fallen in value. Prescribed counterparty risk mandates may also force the bank's repo department to sell the collateral. In addition, in the case at hand there was a risk that general turmoil might cause the bonds to fall even further in value. Many banks probably reasoned that it was important not to sell too late, in order to limit their losses. Meanwhile liquidity diminished in the markets and the general reduction in risk exposure was expected to continue. All this helped create expectations of increased flight to quality and liquidity, reinforcing the herd mentality, while increasing the probability that LTCM would go bankrupt.

Upon the initiative of the US Federal Reserve Bank 14 banks with claims against LTCM agreed to jointly advance 3.65 billion dollars in order to prevent a systemic crisis.

Late in September 1998, LTCM was indeed on the brink of bankruptcy. By then, its equity had fallen from about 4.8 billion dollars to 600 million dollars, that is, by nearly 90 per cent in just nine months.[19] At the initiative of the US Federal Reserve Bank, on September 23, 14 banks with claims against LTCM agreed to jointly advance 3.65 billion dollars in order to continue operating LTCM in the form of a consortium and to unwind the fund's positions in a controlled way. There was a danger that the impact of bankruptcy and an uncontrolled unwinding of LTCM's positions might threat the functioning of the financial markets and thereby create a systemic crisis.

[19] IMF (1998), *World Economic Outlook*, December 1998.

Why a systemic risk?

Systemic risk – a definition

Systemic risks within the financial system arise when the credit or liquidity problems of a market player create substantial credit or liquidity problems for other players.

Systemic risks within the financial system arise when the credit or liquidity problems of a market player create substantial credit or liquidity problems for other players. The latter may thus go bankrupt, although they actually have no problems besides the fact that the first-mentioned player cannot meet its payments. This may eventually lead to severe disruptions in the entire financial system. Systemic risks arise mainly in connection with very large payments between financial market players. For example, a major financial institution may be threatened if a large payment from a counterparty does not materialise or is delayed.

In the case of LTCM, the risk of severe disruptions in the financial system – that certain markets would largely stop functioning – was the central problem that caused the Federal Reserve to consider itself compelled to act.

In this context, it is mainly the banks' *counterparty risks* that are important from a systemic risk perspective. Counterparty risks are credit risks that arise via a bank's exposure to other players in the financial market. What distinguishes counterparty risk from the "ordinary" credit risk that occurs when lending to households and companies is that individual exposures are very large, while the probability of losses is comparatively low. Large exposures coupled with low diversification may nevertheless mean that the consequences of a single payment cancellation are often far-reaching. In the work of bank supervision authorities, for example, counterparty risk has attracted little attention for a long time, but the frequently recurring financial turmoil of recent years has caused central banks in particular to pay more attention to counterparty risk. In the case of LTCM, the consequences for the banks of highly concentrated exposure to a single market player were clear.

Counterparty risk can be divided into *full credit risk* and *replacement cost risk*. Full credit risk exists when credit is granted without collateral. This means that the entire loan amount may be lost. Replacement cost risk exists in the case of lending against collateral. The risk is then that the value of the collateral may decline, so that it does not fully cover the loan amount. Whether a loss occurs thus depends on market movements.

A third type of counterparty risk is *liquidity risk*, which arises when financing for a market player is suddenly withdrawn, thereby exposing this player to a li-

quidity shortage. This may arise when a payment – a loan or loan repayment – from a counterparty does not materialise, but also when a portfolio security cannot be transformed into liquid assets by being sold in the market. In the case of LTCM, it was mainly the latter situation that became a reality for many players, since the market for various types of securities in principal ceased to exist or was at least risked doing so.

Many players experienced an immediate liquidity shortage when the market for various types of securities in principal ceased to exist.

The fact that LTCM was rescued after a number of investment banks supplied capital to the fund on the advice of the New York Federal Reserve demonstrates that if they have problems, hedge funds of LTCM's size can cause de facto systemic risks. In this case, the systemic risk was attributable to the banks' risk exposure to these funds.

The banks' exposure to hedge funds

The banks' exposure to hedge funds can be divided into two categories: direct and indirect exposure.

Direct exposure. Direct exposure include those exposure arising when banks act as counterparties to hedge funds, especially in the repo and derivative markets. Direct exposure also arise by means of investments in and direct lending to these funds. In this case it is important to distinguish between lending against collateral and lending without collateral.

The risk associated with lending against collateral is the same as replacement cost risk, that is, the risk that the value of the collateral will decline so that it does not fully cover the loan amount. This risk is thus especially associated with the repo market, where all lending occurs against collateral. In order for a risk to occur, it is thus necessary both for the counterparty to fail and for the value of the collateral – the bonds – to decline. When it lends without collateral, on the other hand, the bank carries a full credit risk. In the case of LTCM, some sources maintain that a comparatively large proportion of lending was without collateral, although most lending was against collateral. To reduce their replacement cost risk, as indicated, many banks demand a "haircut" when lending against collateral. This means that from the outset, the value of the collateral exceeds the value of the loan.

The size of the banks' direct exposures are generally easy for them to calculate.

Indirect exposure. In cases where hedge funds have payment difficulties, their

counterparties – the investment banks – must often unwind their positions against a fund. This in itself may result in a loss.

Indirect exposure is mainly concerned with counterparties' exposure to certain markets where hedge funds are active.

Indirect exposure are thus concerned with counterparties' exposure to certain *markets*, i.e. the markets where the hedge fund in question is active. The risks of losses and how large these potential losses will be depend mainly on two factors.

First, the funds in question may be active in markets that, from the start, are already characterised by shortages of liquidity. This creates an immediate risk for banks that are exposed to certain hedge funds. This was also reportedly the case with LTCM, which held large investments in markets/instruments characterised by high volatility and low liquidity (this applied, for example, to certain OTC derivatives). LTCM, and thus also its counterparty banks, were often also very large players in the markets they were exposed to.

Second, general market conditions may be unfavourable at the time of unwinding positions. This was clear in the case of LTCM, since the financial markets during the autumn of 1998 were characterised by instability due to the Asian and Russian crises. Among the consequences was a flight to safer investments and the resulting lower liquidity in many markets.

The size of the risk in indirect exposure is thus the same as the risk that the bank in question cannot unwind its market positions in a satisfactory way, or at worst that the market will stop functioning altogether. This risk grows with the size of the bank's positions in relation to the total size of the market.

Unlike direct exposure, it is characteristic of indirect exposure that they are very difficult for the banks to calculate.

Financial stability/instability

The failure or imminent failure of a major market player may in itself lead to instability in financial markets. This may cause any losses resulting from the above-described exposures to end up being larger. Even worse, from a central bank perspective, is that the entire financial market, or large parts of it, may cease to function. (Note the difference compared to the above-described indirect exposure, which only applied to banks with exposures to hedge funds.) In the long term, this may have a far-reaching negative impact on the economy in general.[20]

[20] If a financial market ceases to function, the allocation function that is its primary task also ceases.

As described earlier, market instability caused by the problems of a hedge fund of LTCM's size occurs due to a general reduction in risk exposure and a "flight to quality". This leads to a rapid decrease in market liquidity and an increase in volatility. The failure of a hedge fund may force the fund's counterparties to unwind their positions in the market, leading to an oversupply of certain assets in the same market. This leads to even greater instability in the market. Mere *expectations* that large unwinding of positions are imminent may lead to greater instability. A drastic decline in liquidity often means that bid/offer spreads – the differences between buying and selling prices – increase sharply. This makes it very expensive and sometimes impossible for a bank to unwind a market position.

It was mainly the risk of a turbulent financial market, with all its negative consequences, and the risk that LTCM's counterparty investment banks would suffer major losses in a non-functioning market, that led the Federal Reserve to take the initiative to rescue the hedge fund. The fact that LTCM's bank counterparties risked losses on their loans to the fund was clearly of minor importance in this context. Among the American central bank's main concerns is to protect the stability of the financial market. Market instability and turmoil would certainly have been even greater and had more far-reaching effects if there had been an uncontrolled phase-out of LTCM.

Also worth noting is that even markets outside the initial source of instability often are affected by global turmoil and accompanying "flight to quality". Even market players with no exposure to the distressed hedge fund therefore run a risk of suffering major losses due to the changed market situation.

Worth noting is that even markets outside the initial source of instability often are affected by global turmoil.

How could this happen?

In our opinion, several factors in particular contributed to the collapse of LTCM and the resulting financial market turmoil: *lack of transparency, exaggerated confidence in well-reputed fund managers, inadequate risk management by banks, the inability of models to forecast unexpected events, and major positions held by international investment banks similar to those held by LTCM.*

Factors that contributed to the collapse of LTCM: lack of transparency, exaggerated confidence in well-reputed fund managers and inadequate risk management by banks, among others.

The lack of information about LTCM's portfolio and risk exposure is an obvious reason why lenders and others did not discover the danger in time. Exaggerated confidence in LTCM's star-quality financial team and the fund's high returns also persuaded banks to compromise on their risk monitoring. In the keen competition for status clients like LTCM, banks reportedly granted the fund very generous terms on the collateral it provided in repo transactions and trading in OTC derivatives. There were also very generous counterparty limits and instances of lending without collateral. Since they had no information about the fund's risk exposure, LTCM's banks were also unable to monitor the very large risk exposure that the fund had actually built up by using a large number of banks. As indicated, some observers believe that LTCM tried to give the impression that each bank was an exclusive counterpart, and that each had a satisfactory picture of the fund's overall risk exposure.

Yet the question remains: Why did no one suspect that LTCM's high historic returns were also associated with high risk, especially since Meriwether had been known even earlier for taking very large risks**.** Some observers believe, however, that the rapid growth in financial markets and the expansion of hedge funds in recent years have helped to reduce the number of "price anomalies" (price differentials on assets that should theoretically sell for the same price), thus creating more efficient markets. LTCM and other hedge funds were thereby forced to increase their risks in order to improve returns.

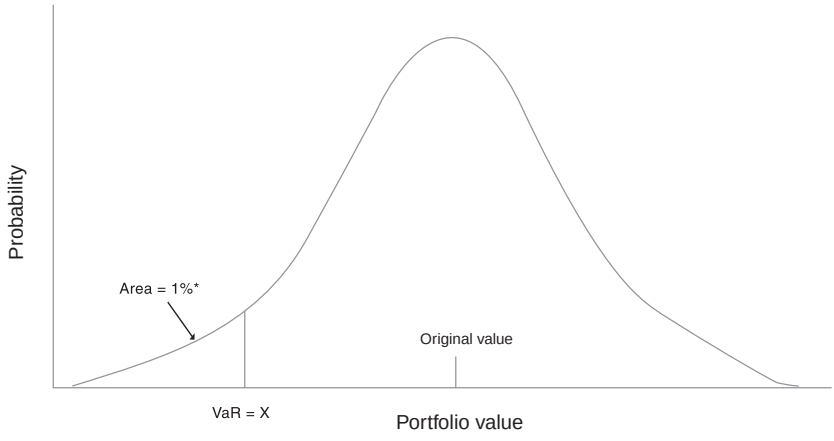
Statistical models that are based on historical data have a difficult time foreseeing extreme events. The probability of a Russian debt moratorium and the resulting panicked flight to quality and liquidity in financial markets was certainly very small, according to calculations based on historical data – but it still happened. Historical correlations ended. Suddenly, for example, prices of all risky assets were fully correlated in principle, since capital flight escalated and was concentrated in time. Some indications, among them the work of Scholes himself, are that faith in the forecasting ability of advanced statistical/mathematical models partly contributed to the collapse of LTCM, though investment decisions and risk exposure choices are ordinarily combined with other assessment criteria and not based exclusively on model results.[21] Earlier in the summer of 1998, "abnormally" large deviations from the historical averages of various financial prices were noted. Market players that still relied on the forecasting ability of models – as LTCM reportedly did – thereby received a signal to increase their exposure, since Russian assets for example had become especially "cheap". For LTCM, which

[21] See the Swedish business magazine *Affärsvärlden*, December 2, 1998.

Value at Risk – a model risk?

VaR indicates the loss that, with a given probability (ordinarily 5 per cent or 1 per cent), will be exceeded during a specified time period.[22] Most variants of VaR are based on the assumption that portfolio return is approximately normally distributed and that historical volatility is a good predictor of future volatility. As for risk exposure under turbulent market conditions, however, it is not normal events but extreme ones that are of interest. It is thus unsuitable to use normal distribution assumptions and an excessively narrow confidence level, since the tail ends of a distribution are its relevant parts – that is, extreme cases with low probability but with potentially severe consequences from a risk standpoint ("tail risk"). Developments during the summer and autumn of 1998 were neither normal nor predictable. Among other things, the calculation of VaR for a trading portfolio is normally based on a given horizon (normally one to five days) in which it should be possible to unwind positions – in other words, it presupposes liquid markets. The problem in this context was probably not the model itself, but its application. Greater use of stress tests – where a portfolio is subjected to a large number of possible outcomes – may perhaps provide better guidance from a risk perspective.

Value at Risk



** Interpretation: The probability is 1 per cent (assumed) for a larger loss than x (for a specific period of time) or, put simply, the maximum loss is x under normal market conditions (assumption).*

The use of the VaR model may also, to some extent, have contributed to strengthening market volatility and herd instincts in the autumn of 1998. Models are often used for establishing trading limits – risk limits that a trader is forced to follow. VaR places greater emphasis on movements that are close in time when calculating historical volatility. When major market movements occur, traders' risk limits can quickly be exceeded, with the result that they must reduce risk – for example by selling assets. When players act this way simultaneously, there is a risk that volatility increases.

[22] See *Value at Risk for Derivatives* by Jahel, Perraudin and Sellin, Sveriges Riksbank Working Papers Series, No. 45, December 1997.

speculated in narrower interest rate differentials, in some markets such tiny differentials were required in absolute terms that its positions had to be loan-financed in order to yield a decent return. Meanwhile, this meant heavier risk exposure.

The application of the popular Value at Risk (VaR) model to market developments probably contributed to some extent (see the box below).

It is wrong, however, to blame hedge funds in general for having caused the financial market turmoil of the autumn of 1998. Several hedge funds also performed better than various share indexes and traditional fund managers during the second half of 1998. LTCM was an extreme case. In normal cases, letting one hedge fund go bankrupt should not cause problems for the world-wide financial system. Nor was direct bank lending to LTCM the problem, since it was largely covered by collateral. On the other hand, indirect exposure to LTCM by major international investment banks helped magnify financial market instability.

The investment banks had reportedly taken large speculative positions similar to LTCM's, among other things in the belief that interest rate differentials related to credit and liquidity risks would narrow.

The investment banks had reportedly taken large speculative positions similar to LTCM's, among other things in the belief that interest rate differentials related to credit and liquidity risks would narrow. LTCM's historically very high return may have lured investment banks into believing there was room for more players to make profits from convergence trading in bond yields. Some figures in the press claim that as part of their strategic positions, investment banks had tied around 3,000 billion dollars to the American bond market, while LTCM had positions equivalent to some 80 billion dollars.[23] One anonymous – but well known – hedge fund manager puts it this way: "The proprietary trading desks of the brokerage firms and banks are the biggest hedge funds of all. If one of them goes bust, we are all in the soup."

Policy measures

However, it is important to point out that it was primarily the hedge funds' counterparties – i.e. the banks – that failed to pursue proper risk management.

The course of events during the autumn of 1998 related to the problems of LTCM has led to various discussions of what can/should be done to reduce the risk of a repetition. There have been calls for tighter regulation of both investment banks and hedge funds.

[23] *The Economist* (1998), "The Risk Business," October 17, 1998.

Most observers agree that the lack of transparency in the investment portfolios of hedge funds is a problem and that greater transparency would be an advantage. However, it is important to point out that it was primarily the hedge funds' counterparties – the banks – that failed to follow proper procedures. Most measures and reforms should thus focus mainly on the banks – an opinion shared by most observers. Another reason is that when major financial market players (i.e. the banks) have problems, that is when systemic risks occur and market stability is threatened. (The systemic risk aspect is what financial supervisory authorities and central banks focus on.) A working group appointed by the Basle Committee on Banking Supervision also concluded that the potential range of measures mainly involve the banks.[24]

These possible measures may be divided into *indirect* ones aimed at the counterparties of hedge funds, and *direct* ones aimed at hedge funds.

Stress tests should be linked with VaR analyses and should be viewed as a necessary complement to VaR.

Among the *indirect measures* aimed at banks that have been discussed, the main one is an improvement in risk management. The banks must become better at assessing credit risks, most observers agree. Discussions often point to the need for regularly recurring *stress tests* of the banks' positions vis-à-vis funds. Stress tests result in estimates of how different types of market developments would hypothetically affect the market value of their positions. These tests thus provide a picture of the risk profile represented by the banks' positions. Stress tests should be linked with VaR analyses and should be viewed as a *necessary* complement to VaR. Banks would certainly develop greater risk awareness if stress tests were used more often. One conceivable consequence of better risk management by banks is that in a longer perspective, this will also lead to somewhat lower risk-taking by the funds, i.e. their leveraging may not exceed a certain limit.

As for proposals to change formal rule systems, for example BIS rules on capital adequacy, it is clearly difficult to introduce rules aimed specifically at hedge funds. On the other hand, a review of rule systems is undoubtedly needed. Today's rules should not work in ways that wrongly favour a given type of risk-taking, thereby (perhaps) creating incentives for "unsound" investments and lending.

Introducing new, differentiated rules for bank exposure to hedge funds without first evaluating today's rules might otherwise result in precisely such effects.

[24] "Banks interactions with highly leveraged institutions", Basle Committee on Banking Supervision, BIS (Basel 1999).

As for any demands that banks will be required to report their current exposures to hedge funds, the question also arises whether there should be special rules governing exposures to hedge funds in particular. After all, the problem is how this should relate to other rules on a bank's maximum exposure to the same counterparty. It is simply difficult to draw distinctions between hedge funds and a bank's other counterparties.

More stringent rules concerning the transparency of banks may be desirable in order to protect the stability of financial markets.

More general rules on the transparency of banks may be desirable, however, precisely in order to protect the stability of financial markets.

For example in the risk-weighting of bank exposures, there are also some questions that should be examined more closely. One is the comparatively low risk-weighting of many OTC derivatives for capital adequacy purposes. A bank's repo transactions with hedge funds, where it lends money against bonds as collateral, is another example. Today there are no formal requirements that a bank must demand extra collateral (*haircut*) for the risk that the value of the collateral will fall and thereby not fully cover the amount of the loan.

As for *direct measures* aimed at hedge funds, there are certain possibilities, but also difficulties, in implementing them. Examples of suitable measures might be better risk management requirements for the funds and perhaps also requirements that they supply information to the appropriate authorities. Here too, however, there is a problem in distinguishing between hedge funds among other market players. For example, there must be clear criteria as to which funds should be classified as hedge funds. Another problem is that hedge funds are often active, or rather registered, in countries that have more liberal rule systems. Imposing tougher requirements in the United States and in most of Europe would thus have no effect at all. However, better risk management by hedge funds would undoubtedly reduce their risks of major losses.

Some observers claim that hedge funds are, in fact, far from completely uncontrolled and unregulated.

Some observers, especially among those who are working in the industry themselves, believe that hedge funds are, in fact, far from completely uncontrolled and unregulated. After all, they have made a commitment to their clients, their investors, to act according to a given strategy – a strategy that must be followed.

Conclusions

This article has discussed the operations of hedge funds and the instability caused by the failure of the LTCM hedge fund, the role these funds play in the market, the consequences of this and what changes in rule systems are possible and probable.

After this review, we can draw the following conclusions:

- Investments by hedge funds are generally less risky than is often claimed. There are many indications that in terms of risk-taking, LTCM was an extreme case.
- The risks generated by the failure of LTCM in the autumn of 1998 mainly involved the stability of financial markets, not the direct loan losses that banks would face if LTCM went bankrupt.
- The most important reason for the failure of LTCM was that its counterparties, i.e. its banks, had inadequate procedures, mainly in terms of risk management.
- Any changes in existing rule systems should therefore aim primarily at banks, not hedge funds. What makes large-scale regulation inadvisable is that it risks being ineffective both in terms of its purpose and a smooth allocation of credits.

Finally, it is worth pointing out that hedge funds normally help to improve the liquidity of markets, among other things by seeking to exploit "abnormally" large interest rate differentials, as LTCM did. In this way, hedge funds normally play an important role in financial markets.

What makes large-scale regulation inadvisable is that it risks being ineffective both in terms of its purpose and a smooth allocation of credits.

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Option prices and market expectations

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Extracting information from financial prices is of interest both to market participants and to public authorities such as central banks. Market participants are for instance interested in forecasting future volatility, since it is an important variable in portfolio management. To a central bank, it is important to be able to interpret market participants' expectations concerning future monetary policy. It is also essential to a central bank to form an opinion of what market participants believe about future developments of various financial assets, such as equities and foreign exchange rates. A central bank's ability to understand market expectations is of great importance to compare the central bank's view of the economy with the market's view, but also because market expectations can be self-fulfilling to some extent.

It is possible to deduce the market's assessment of the level of uncertainty and any asymmetries in the risk assessment by using the prices of various derivative instruments.

An example of a financial indicator that is of interest to central banks is the implied forward interest rate curve, which is employed to estimate market expectations of the future key interest rate.[1] This type of forecast results in an estimate of the expected future interest rate level. In general, however, it provides no indication of the degree of uncertainty concerning the future interest rate, or whether the market believes that risk is predominantly on the upside or on the downside. Nevertheless, it is possible to deduce the market's assessment of the level of uncertainty and any asymmetries in the risk assessment by using the prices of various derivative instruments. In this article, we use option prices to derive

[1] See, for example, Svensson (1995).

"implied probability distributions". This kind of distribution can be interpreted as the market's assessment of the future probability distribution for the underlying asset on which the options are issued.

Implied probability distributions

In order to facilitate the interpretation of implied probability distributions, we begin with a brief discussion of option pricing theory.[2] There are a number of pricing models available, but the Black-Scholes model[3] (1973) is the most commonly used formula for pricing European option contracts.[4] This model assumes that the price of the underlying asset, *S*, follows a geometric Brownian motion (GBM).[5] This implies that the price of the underlying asset will be lognormally distributed and its return will be normally distributed with constant variance. Based on these and other assumptions, Black and Scholes showed that the price of a European call option, *c*, can be written as:

$$c = S\Phi(d_1) - Xe^{-r(T-t)}\Phi(d_2)$$

where

$$d_1 = \frac{\ln\left(\frac{S}{X}\right) + \left(r + \frac{\sigma^2}{2}\right)(T-t)}{\sigma\sqrt{(T-t)}}$$

$$d_2 = d_1 - \sigma\sqrt{(T-t)}$$

and where $\Phi(\cdot)$ denotes the standardised cumulative normal distribution, S is the price of the underlying asset, X is the strike price, r is the risk-free interest rate dur-

[2] For a further discussion of option pricing theory, we recommend e.g. Hull (1998).

[3] Modified by Garman-Kohlhagen (1983) for currency options.

[4] Option contracts can be divided into two major categories: American-style and European-style options. European options can only be exercised on the expiration date, while American options can be exercised at any time during the life of the option until the expiration date.

[5] GBM is a model for the stochastic process that asset prices can be assumed to follow in continuous time. According to the model, the change in the asset price, dS, can be written as $dS = \mu S\,dt + \sigma S\,dz$,, where μ is the expected return, σ is the volatility, dt denotes the time increment and dz is the increment of a standardised Wiener process. See, for example, Hull (1998) for further details.

ing the option's life, $(T-t)$ is the time to expiration of the option, and σ is the volatility of the underlying asset during the life of the option (that is, the standard deviation of the return on the underlying asset). It is clear from the expression above that the price of the option is a function of the five variables and S, X, r, $(T-t)$ and σ. The values of all variables are known to the market, with the exception of the volatility. To be able to price an option, market participants must therefore make an estimate of the future value of volatility during the life of the option.

If we instead regard the actual quoted price as the "correct" price and back out the volatility from the Black-Scholes formula, we obtain what is usually known as the *implied volatility*. The implied volatility is usually regarded as an important source of information, since it is likely to reflect market expectations of future volatility.[6] If, for example, the implied volatility of a currency option on Swedish kronor against US dollars with one month to expiration is 5 per cent, this can be viewed as indicating that the market believes the SEK/USD volatility will be about 5 per cent on an annual basis during the next month.

The implied volatility is usually regarded as an important source of information, since it is likely to reflect market expectations of future volatility.

Since the Black-Scholes model assumes that the return on the underlying asset is normally distributed, this implies that the market's perception of the uncertainty of the future outcome is symmetric. A number of studies demonstrate, however, that prices of financial assets rarely seem to follow a geometric Brownian motion.[7] This means that the Black-Scholes model does not hold and that the underlying asset's return is not normally distributed. It is therefore of interest to find the "true" distribution, since it may provide an indication of the market's risk assessment of future developments in the underlying asset.

In a similar manner as implied volatility is derived from option prices, the entire distribution – "the implied probability distribution" – of the underlying asset can also be estimated. This is possible because the price of an option can be written as a function of the probability distribution of the underlying asset.[8] If the Black-Scholes model and its assumptions are valid, we know that

In a similar manner as implied volatility is derived from option prices, the entire distribution – "the implied probability distribution" – of the underlying asset can also be estimated.

[6] See, among others, Galati and Tsatsaronis (1996) and Aguilar (1999).
[7] See, for example, Campbell et al. (1997).
[8] The explicit relation between the option price and the probability distribution can be found in Appendix 1.

returns are normally distributed. In that case, it is trivial to derive the implied distribution by using the implied volatility. The fact that returns on financial assets do not seem to meet the assumptions behind the Black-Scholes model means, however, that this model is not suitable as a basis for estimating implied distributions. Instead, a number of alternative strategies may be used. The choice of method largely depends on what data is available.

When there are several option prices available, the implied distribution may be estimated by assuming that the underlying asset price follows a given type of distribution. We then estimate the parameters that determine the specific shape of the distribution, by minimising the difference between the observed option prices and the prices implied by the estimated distribution. One specification often used in this context is a weighted average of two lognormal distributions.[9] The implied distribution is then obtained by estimating the expected values and variances of both distributions as well as a weighting parameter that determines the relative influence of the distributions on the final result. The method is very flexible, which means that it is possible to obtain a wide variety of different implied distributions.[10] This method can therefore capture commonly observed characteristics of financial returns, such as asymmetries and "fat tails" in the probability distribution. In this way, departures from the assumptions of the Black-Scholes model can be taken into account in a relatively simple way.

The method described above implies that five variables must be estimated, which requires at least five simultaneously quoted prices for options with the same maturity, but with different strike prices. In the Swedish OMX option market, for example, this is not a problem, at least for short term options. However, the situation is different in the currency options market, where there are usually only three option prices quoted. For currency distributions, we have therefore used an alternative method suggested by Malz (1997), which is not dependent on a large number of observed option prices.[11]

The implied probability distribution can be viewed as the market's estimate of the *ex ante* probability distribution for the price of the underlying asset on a future date.

Regardless of which specific method we employ to estimate the implied distribution, the result may be interpreted in the same way. The implied probability distribution can be viewed as the market's estimate of the *ex ante* probability distribution for the price of

[9] See Melick and Thomas (1997).

[10] See Appendix 1 for a more complete description of the estimation method. See also Bahra (1997) for a thorough review of this and other estimation methods.

[11] See Appendix 2 for a description of the method. See also Malz (1997).

the underlying asset on a future date, i.e. on the expiration date. However, it should be noted that the estimated distribution is a "risk-neutral" distribution. Hence, the result is the probability distribution that market participants would have expected if they were risk neutral (see box).[12]

Facts: Risk-neutral probability distributions

One important aspect should be taken into account when interpreting the information in implied distributions. The methods used for pricing options are generally based exclusively on the principle of absence of arbitrage opportunities in financial markets. A major advantage is that no information on investors' preferences is needed in order to price options. In other words, the price of options and other derivative instruments is not affected by the degree of risk aversion among investors. Consequently, it is not possible to obtain any information about investors' preferences from option prices. This means that the estimated implied distribution does not take into account the degree of risk aversion of investors, and the result is therefore usually called a *risk-neutral distribution*.

We can therefore interpret the implied distribution as the market's estimate of the future probability distribution of the underlying asset, if market participants were risk neutral. However, if investors are risk averse, the market's "true" perception of the distribution will differ from the implied risk neutral probability distribution. To get an idea of the difference between these distributions, the utility function of investors must be known or estimated, for example by estimating their degree of risk aversion. Rubinstein (1994) shows that (given assumptions about constant relative risk aversion and the size of the market's risk premium) the true equity price distribution shifts somewhat to the right relative to a risk-neutral distribution, but the general shape remains the same. It therefore seems reasonable to assume that the variance, skewness and degree of kurtosis of the implied risk-neutral distribution are relatively close to the market's perception of the "true" moments. Hence, variations over time in the implied moments should provide a good indication of changes in the market's assessment of future developments in the underlying asset.

It is possible to clarify the interpretation of the information contained in implied distributions by calculating a number of standardised measures, so-called "moments", that describe different characteristics of the distributions. The standard deviation of the distribution is a measure of its dispersion.[13] If the standard deviation

[12] If a market participant is risk-neutral, this means that he/she is indifferent between two investment alternatives with the same expected return, even if one alternative is riskier than the other. One consequence of the fact that the implied distribution is risk-neutral is that the expected value of the distribution (the mean) is equal to the forward price of the underlying asset, since the forward price is determined by the current price and the risk-free interest rate. See, for example, Hull (1998).

[13] The standard deviation for a stochastic variable X is defined as

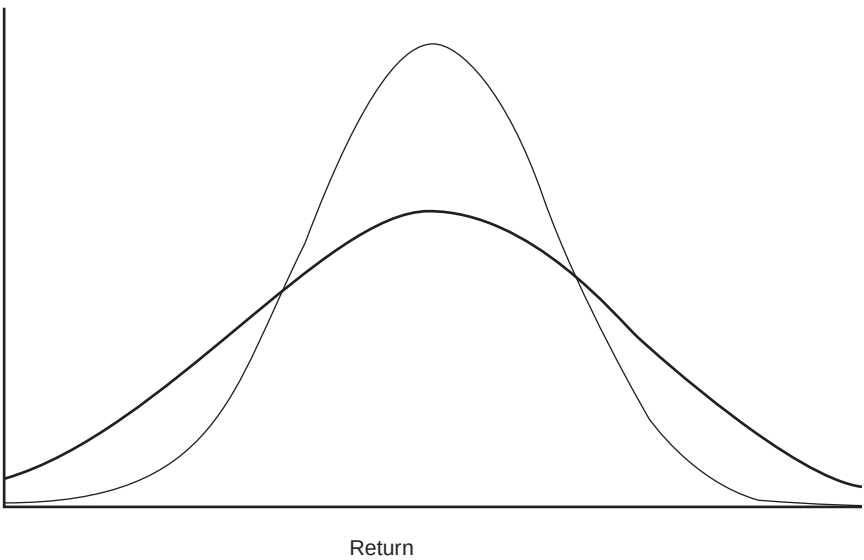
$$\sigma = \sqrt{E[(X - E[X])^2]},$$

where $E[\cdot]$ denotes the expected value.

is high, this may be seen as an indication that the market associates great uncertainty with the development of the underlying asset price during the life of the options (see Chart 1). It is usually more informative to study implied distributions on the asset's return rather than on its price. This is due to the fact that the price standard deviation varies as the price level changes, making it difficult to compare the standard deviation on days with different price levels. In general, the standard deviation of returns does not depend on the price level. As a result, standard deviations of returns on two different dates are always comparable. In this article, we will therefore focus on return distributions for different assets.

Another moment that can be used to describe the characteristics of a distribution is the skewness, which measures the asymmetry of the distribution.[14] In general, asset returns are assumed to be normally distributed (as in the Black-Scholes model) or at least symmetric, i.e. implying zero skewness. If the skewness of the implied distribution is positive, there is more mass in the right-hand tail than in

Chart 1. Normal distributions with high (wide line) and low (thin line) standard deviation, respectively



[14] A common measure of skewness is the standardised third central moment, which is defined according to

$$\gamma_1 = \frac{E[(X - E[X])^3}{\sigma^3},$$

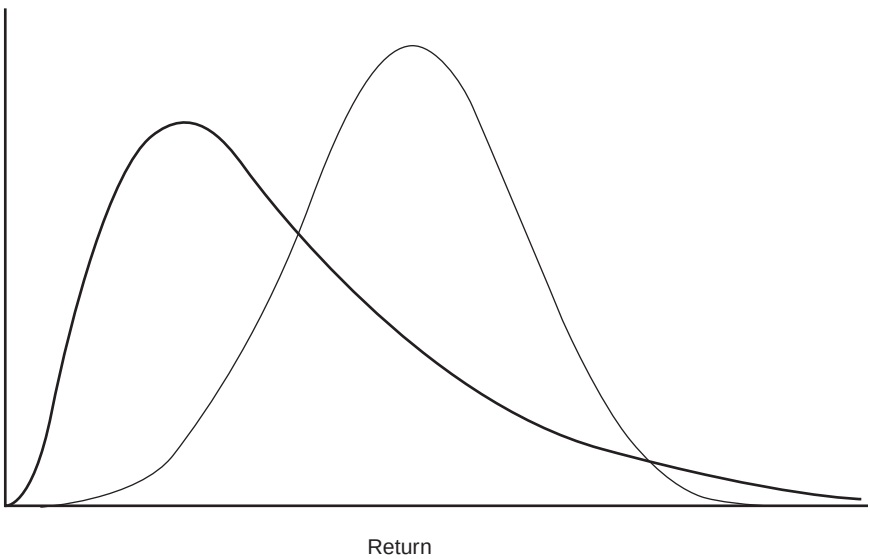
where σ is the standard deviation.

the left-hand tail of the distribution (see Chart 2). Hence, positive skewness indicates that the market perceives the probability of positive outcomes to be higher than the probability of negative outcomes. Similarly, negative skewness can be viewed as an indication that the probability of negative returns is greater than for positive returns. The skewness of the distribution can therefore be used to ascertain whether the risk of an asset is perceived to be on the upside or on the downside.

The skewness of the distribution can be used to ascertain whether the risk of an asset is perceived to be on the upside or on the downside.

Another useful moment is the kurtosis, which measures the thickness of the tails of the distribution.[15] For a normal distribution, the degree of kurtosis is zero, while a positive value indicates that the distribution is more peaked and has fatter tails (see Chart 3). Thus, positive kurtosis implies that the probability of extreme outcomes, positive or negative, is high compared to a normal distribution. The

Chart 2. Symmetric distribution (thin line) and distribution with positive skewness (wide line)



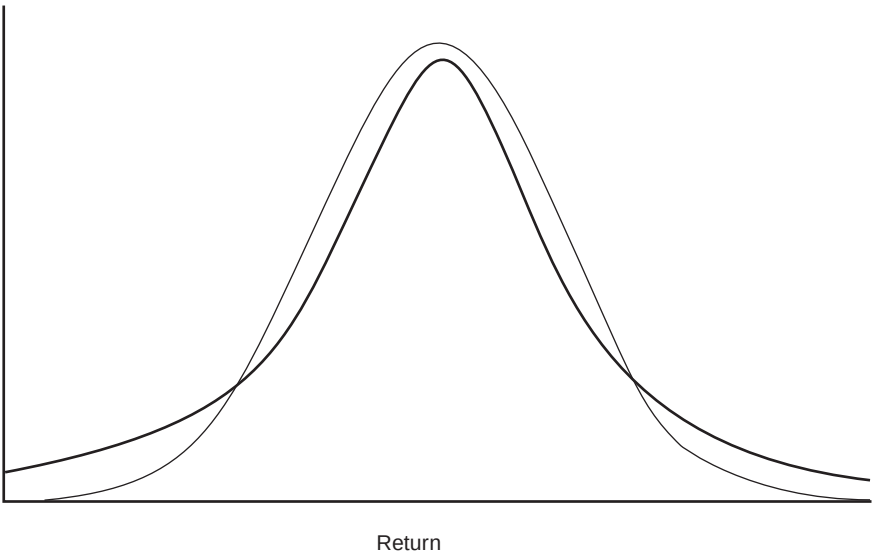
[15] The degree of kurtosis is generally measured with the standardised fourth central moment, which is defined according to

$$\gamma_2 = \frac{E[(X - E[X])^4]}{\sigma^4} - 3.$$

The value 3 is subtracted from the expression since a normal distribution has a "non-standardised" kurtosis of 3.

level of kurtosis can therefore provide an indication of the market's perception of the probability of major price changes (regardless of direction) in the underlying asset. Empirical studies of financial assets show that the kurtosis of the distribution often is positive; see e.g. Campbell et al. (1997) and Fama (1976).

Chart 3. Normal distribution (thin line) and distribution with positive kurtosis (wide line)



Examples of implied distributions

In this section, we present examples of estimated implied distributions and discuss the interpretation of the information content in these distributions. We begin by studying distributions for interest rates and equities. Since there is no data available for Swedish interest rate options, we choose to illustrate the method using Italian three-month interest rates.[16] To demonstrate the results for equities, we use options on the Swedish OMX index. For both of these two underlying assets, a mix of lognormal distributions is used to estimate the implied probability distri-

[16] At the OM exchange as well as in the OTC market, options are traded with Swedish short-term interest rates as the underlying asset, but not enough exercise prices are traded to allow estimation of implied distributions for Swedish short-term interest rates. The Riksbank currently uses an alternative method for estimating interest rate distributions, based on the prices of bonds and Treasury bills instead of option prices (see Sveriges Riksbank, *Inflation Report*, 3/1998, pp. 15–16.).

butions. We end this section with some examples of implied distributions using currencies as the underlying asset. To estimate these, we used the Malz (1997) method.

Facts: Options markets

Options are traded on exchanges, as well as interbank on the "over-the-counter" (OTC) market. Exchange-traded options are quoted for standardised exercise prices and expiration dates, usually expiring in March, June, September and December. OTC options are traded directly between banks and have non-standardised expiration dates. This means that it is possible any day to trade an option with, for instance one-month to expiration. An advantage of OTC-traded options is the fact that the options can be tailor made to fit the customer's needs. It is mainly currency and interest rate options that are traded in the OTC market. In fact, the major part of the global trade in currency options takes place on the OTC market. Hence, it seems better to use OTC quotations in empirical studies, since trading is probably more liquid than for exchange traded options. Furthermore, more currency pairings are traded on the OTC market. Currency options on smaller currencies, such as the Swedish krona, are not traded on exchanges at all.

Yet another advantage of OTC-traded options is that prices are quoted directly in terms of implied volatility. According to a market agreement, the quoted volatility is substituted into the Black-Scholes formula to obtain the option price. The fact that market participants use the Black-Scholes model does not necessarily mean that they believe that the Black-Scholes model holds.[17] The model is simply used to transform implied volatility quotes into option prices and vice versa. One advantage of quoting prices in terms of volatility is that implied volatility does not necessarily need to change as the price of the underlying asset fluctuates. Therefore, market-makers do not need to continuously update their quotes as the underlying price changes.

An advantage of OTC-traded options is that prices are quoted directly in terms of implied volatility.

Distributions for interest rates

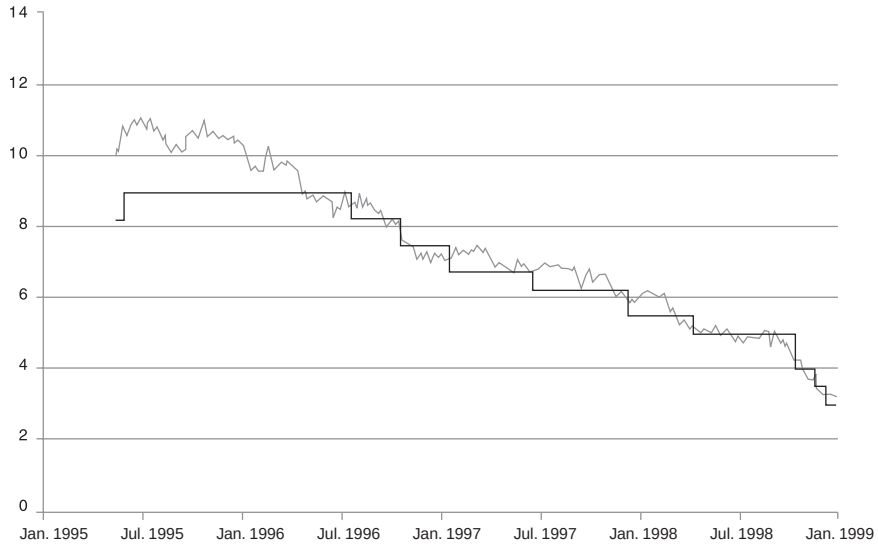
The London International Financial Futures and Options Exchange (LIFFE) functions as a marketplace for trading in options and forward contracts, with dif-

[17] It is conceivable that some market participants price options using an entirely different theoretical valuation model, for example one that takes into account stochastic volatility. If this is the case, the estimated price is then substituted into the Black-Scholes formula to derive the implied Black-Scholes volatility. The implied volatility value is then quoted as the "price" at which the market participant is willing to trade the option. The price that is actually paid if a transaction takes place is calculated by substituting the quoted implied volatility into the Black-Scholes formula.

ferent Eurorates as underlying assets.[18] The three-month Eurolira interest rate is one of the underlying assets at LIFFE.[19] Chart 4 shows the three-month interest rate on the Eurolira contract since May 16, 1995, when LIFFE introduced options on this contract, as well as the Italian discount rate during the same period. The chart shows that the three-month rate has followed the discount rate very closely since early 1996. It is also evident that this is not only a result of the Eurolira rate adapting to new discount rate levels, but also because it often has predicted future changes in the discount rate.

The Italian three-month rate therefore seems to have given an indication of the level of future discount rates. It does not, however, provide any information about the market's assessment of the uncertainty of future interest rates, or whether the market believes that the risk is mainly on the upside or the downside. This type of information can, on the other hand, be gathered from implied probability distributions.

Chart 4. Three-month Eurolira interest rate and the Italian discount rate. Per cent per year



[18] A Euro interest rate is the interest rate paid on a deposit, i.e. a standardised contract for interbank lending. Unfortunately, LIFFE does not quote any derivative contracts that use Swedish interest rates as underlying asset.

[19] The underlying asset actually consists of a forward contract on the three-month interest rate. However, this is irrelevant for the interpretation of implied distributions.

Chart 5 shows estimated implied distributions for the three-month Eurolira interest rate on three dates: January 2, 1996; September 30, 1996; and September 29, 1997. In all three cases, the remaining life of the options was 77 days. The estimated implied distributions can therefore be interpreted as the market's assessment of the probability distribution for the Italian three-month interest rate 77 days ahead in time, on each respective date. The three dates we have chosen cover an interesting period, during which the market focused on Italy's efforts to qualify for membership in the European Monetary Union (EMU). As the perceived likelihood of a future membership increased, interest rates fell sharply, as illustrated in Chart 4.

The clearest pattern visible in Chart 5 is that as interest rates fell, the variance in the distributions also decreased. In other words, uncertainty about future interest rates decreased over time. This is also clear from Table 1, which shows the first four estimated moments of the distributions. The table clarifies how the higher moments changed over time. Like the variance, the level of kurtosis decreased sharply, which can be interpreted as meaning that the risk of extreme outcomes diminished as interest rates fell.

Chart 5. Implied distributions for three-month eurolira rate, 77 days ahead at each date

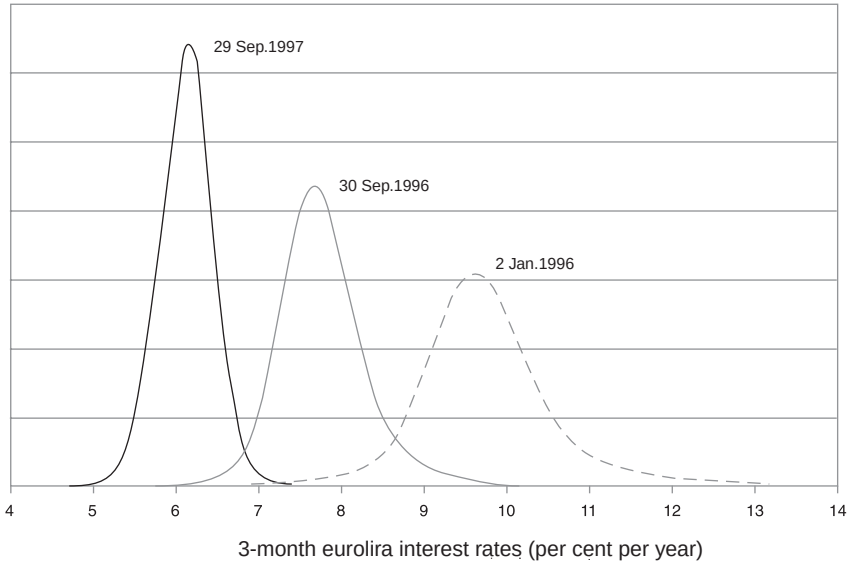


Table 1. Estimated moments of the implied eurolira distributions on three different dates

	January 2, 1996	September 30, 1996	September 29, 1997
Mean (% per year)	9.73	7.72	6.08
Standard deviation	0.86	0.54	0.33
Skewness	0.88	0.68	–0.10
Kurtosis	3.20	1.92	0.18

The distributions' skewness has also changed over time. Both distributions for 1996 have positive skewness, which can be seen as an indication that the market believed the risk in forecasted interest rates was mainly on the upside. There may be a number of different explanations for this, including fears that the Italian government would be forced to abandon the EMU convergence programme in favour of a more expansive economic policy. In mid-September 1997, the EU finance ministers held an informal ECOFIN meeting, where the conversion rates of the future EMU currencies were one of the issues discussed. Comments after the meeting were interpreted by the market as meaning that Italy was likely to be accepted as a member of EMU. Chart 5 and Table 1 show how the implied distribution was affected by this event, among others. Not only did the standard deviation and kurtosis decrease sharply compared to the previous year, but it is also apparent that the skewness was greatly affected. Unlike the distributions in the earlier cases, the distribution on September 29, 1997 has negative skewness. Thus, option prices indicate a change in the assessment of future interest rate risk, from mainly having been on the upside to the downside. This seems natural if the market considered it likely that Italy would become an EMU member from the start.

When the underlying asset is a short-term interest rate, implied distributions are naturally of great interest to central banks, since they can serve as indicators of market perceptions of future monetary policy.

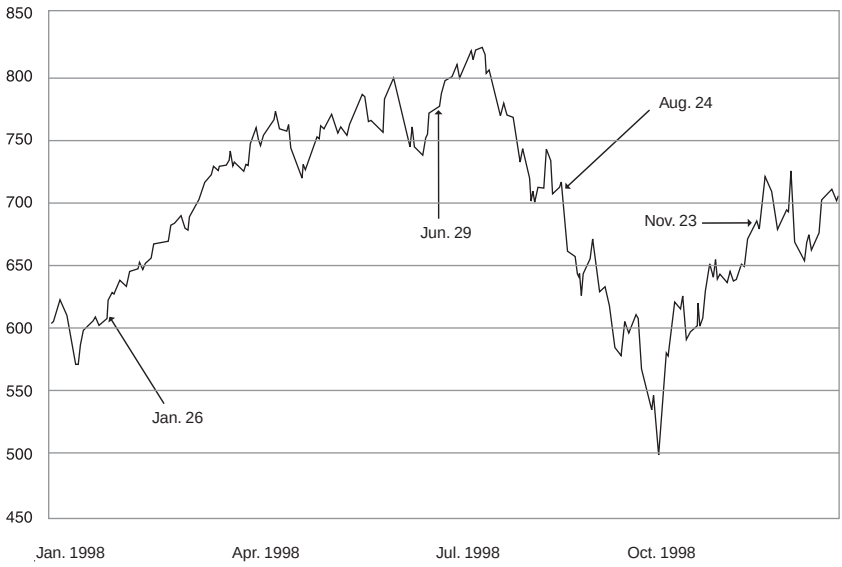
The above examples show that studies of implied distributions can provide extensive information of market expectations. In particular, this is the case concerning information about the degree of uncertainty perceived by the market, which can be inferred from the standard deviation and the kurtosis of the distribution. Furthermore, the measure of skewness provides an indication of whether the market perceives the risk to be evenly balanced or asymmetric during the remaining life of the options. When the underlying asset is a short-term interest rate, implied distributions are naturally of great interest to central banks, since they can serve as indicators of market perceptions of future monetary policy.

Distributions for equities

The stock market is also a market where implied distributions can function as a valuable indicator. In most countries, derivative instruments written on individual equities or equity indices are traded as standardised contracts on exchanges. In Sweden, there are standardised options on a number of the largest stocks on the Stockholm Stock Exchange. However, a central bank is likely to be more interested in the stock market as a whole than in prices of individual equities, since variations in the overall market value can be assumed to influence economic developments. The OM Stockholm Exchange functions as a marketplace for standardised options and forward contracts, with the OMX Index as the underlying asset. The OMX Index is a value-weighted index, consisting of the 30 most heavily traded equities on the Stockholm Stock Exchange, and should therefore provide a good indicator of the entire Swedish stock market.[20]

1998 was a turbulent year for the stock market. Between January 1 and July 20, the OMX Index increased by 31.7 per cent, then plummeted when the Russian financial crisis became a fact. The entire gain of 1998 was wiped out during the autumn, and in addition, the stock market had lost another 18.5 percent of its

Chart 6. The OMX Index during 1998



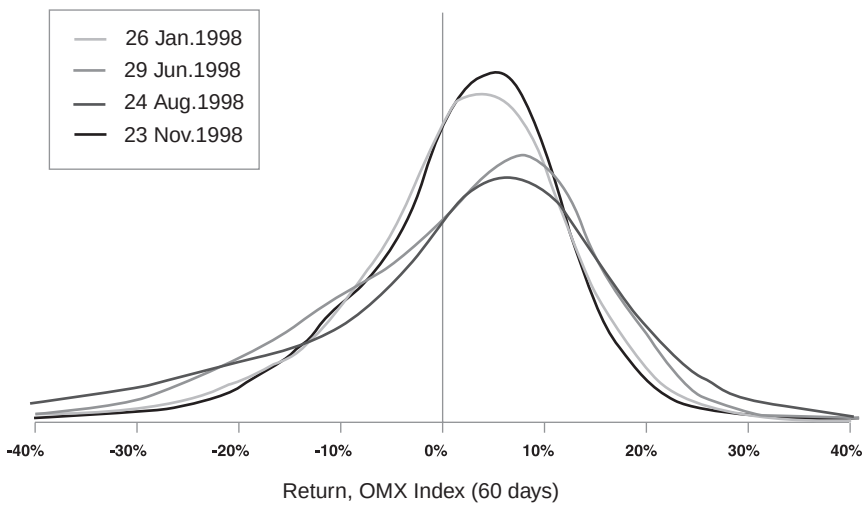
[20] The shares in the OMX Index account for approximately 67 per cent of the aggregate market value of the Stockholm Stock Exchange, as of December 1998.

value by October 8. During the final months of the year, the stock market recovered, ending the year with a total gain of 15.6 per cent. Chart 6 displays the OMX Index during 1998.

By studying the implied distribution for the OMX Index on various occasions during 1998, it should be possible to extract information about the way the market expectations of future share prices changed over time. We have chosen four days during 1998 (marked in Chart 6), for which we have estimated the implied distributions: January 26, June 29, August 24 and November 23. On all these dates, there existed OMX options with 60 days to expiration, and these are the options used in calculating the implied probability distributions. The four dates used in this analysis occurred at the beginning of an extended stock market rally, just before the peak was reached, after a period of sharply falling stock prices, and after a strong recovery, respectively.

Chart 7 shows the estimated implied distributions on the four chosen occasions. It is clear from the chart that all four distributions have negative skewness. This may be due to the market perceiving the risk as mainly being on the downside, but another probable explanation is that option prices could be influenced by investors' hedging strategies. Participants with positions in the stock market can use "out-of-the-money" put options to protect themselves against large downturns.[21]

Chart 7. Implied distributions for the OMX Index



[21] A call (put) option is said to be out-of-the-money when the exercise price of the option is higher (lower) than the price of the underlying asset. If the opposite is true, then the option is in-the-money, whereas an option is said to be at-the-money if the price of the underlying asset is equal to the exercise price.

Excess demand may then force up the price of these options, resulting in negative skewness in the implied distribution. [22]

Nevertheless, there are significant differences between the four estimated distributions. For instance, comparing the January distribution with the one in June, it is apparent that the left-hand tail in the June distribution is longer and fatter. In addition, it is clear that the variance of the June distribution is higher than that of the January distribution. This indicates that in late June (when the stock exchange had increased by more than 25 per cent), the market was becoming increasingly concerned about a large downturn in the stock market. By August 24, the OMX Index had fallen about 15 per cent from its July peak, leading to increased concern for further large losses, which was reflected in the implied distribution for this date. The dispersion in the August distribution had increased compared to the June distribution, and furthermore, the negative skewness increased. Thus, according to options prices, market participants expected further large price movements during the following 60 days, and viewed the risk as being mainly on the downside.

Having reached its lowest level of the year on October 8, the OMX Index started to recover. By November 23, the OMX had increased about 32 per cent compared to its lowest level, and the market's assessment of future stock market movements had changed. The implied distribution on November 23 is almost identical to the January distribution, indicating that concerns for a new stock market crash had fallen considerably. In retrospect, it turned out that during the 60-day period following November 23, the OMX Index was, in fact, relatively stable.

Distributions for currencies

Developments in the exchange rate are important to a central bank, among other things because the exchange rate is a key variable for forecasting purposes. Hence, although Sweden has a floating exchange rate and Swedish monetary policy aims at achieving price stability, market expectations of the krona are of great interest to the Riksbank.

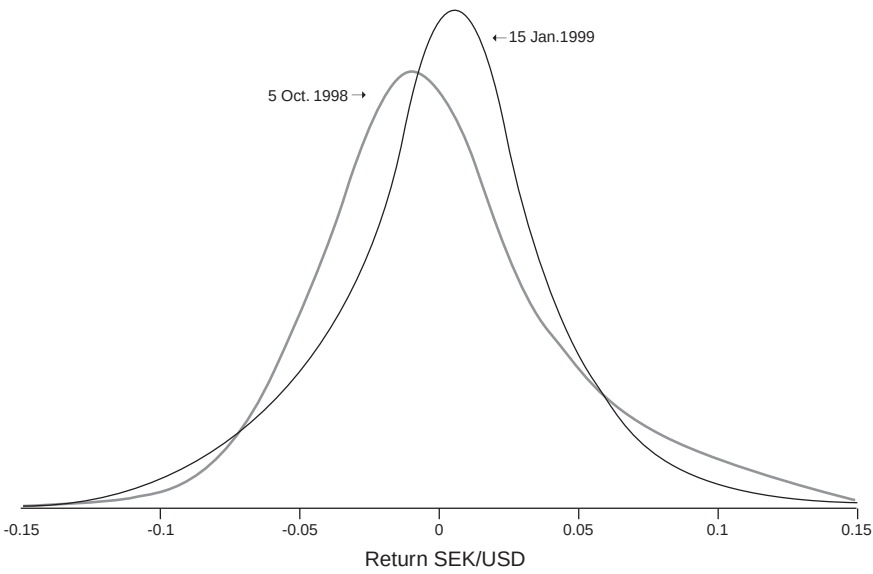
Although Sweden has a floating exchange rate and Swedish monetary policy aims at achieving price stability, market expectations of the krona are of great interest to the Riksbank.

[22] In a perfect market, option prices (even for out-of-the-money put options) should only be determined by arbitrage relations and not by supply and demand conditions. Institutional imperfections (such as transaction costs, non-continuous trading, etc) may, however, prevent arbitrage relations from holding exactly. Another possible reason why options may not be priced strictly based on arbitrage relations is if the option's payoff cannot be replicated by a dynamic trading strategy. This may be the case if there is stochastic volatility or discrete jumps in the process of the underlying asset. See, for example, Bates (1991) for a further discussion.

Currency options written on the Swedish krona are only traded on the OTC market. Unfortunately, we only have access to quotes for three exercise prices for one-month options on a daily basis.[23] Due to the lack of data, we use the Malz (1997) method to estimate implied probability distributions for the Swedish krona.[24] We illustrate the interpretation of exchange rate distribution by studying the implied probability distribution derived from SEK/USD one-month options on two different occasions. Chart 8 shows the implied SEK/USD probability distributions on October 5, 1998 and January 15, 1999, respectively.

During the autumn of 1998, the krona depreciated relatively sharply. This might have been a consequence of the stock market crisis and the global financial turbulence, which led to a "*flight to quality*" behaviour. On such occasions, the krona tends to weaken against major currencies, which are viewed as safer in turbulent times. Chart 8 shows that the implied probability distribution for October 5, 1998 has positive skewness, i.e. there is more mass in the right-hand tail than in the left-hand one. This can be viewed as an indication that market participants believed that there was a higher probability for the Swedish krona to continue to

Chart 8. Implied SEK/USD probability distributions, October 5, 1998 and January 15, 1999



[23] For other maturities, we only have access to quotes for at-the-money options.
[24] See Appendix 2 for a description of the method.

depreciate than to appreciate during the forthcoming month.[25] In contrast, the implied probability distribution for January 15, 1999 has negative skewness. Hence, at this time market participants viewed an appreciation of the Swedish krona against the dollar as more likely than a depreciation. In early 1999, the krona strengthened against the dollar and it is evident that market participants changed their risk assessment in favour of the krona.

Table 2. Estimated moments for the SEK/USD distributions on October 5, 1998 and January 15, 1999

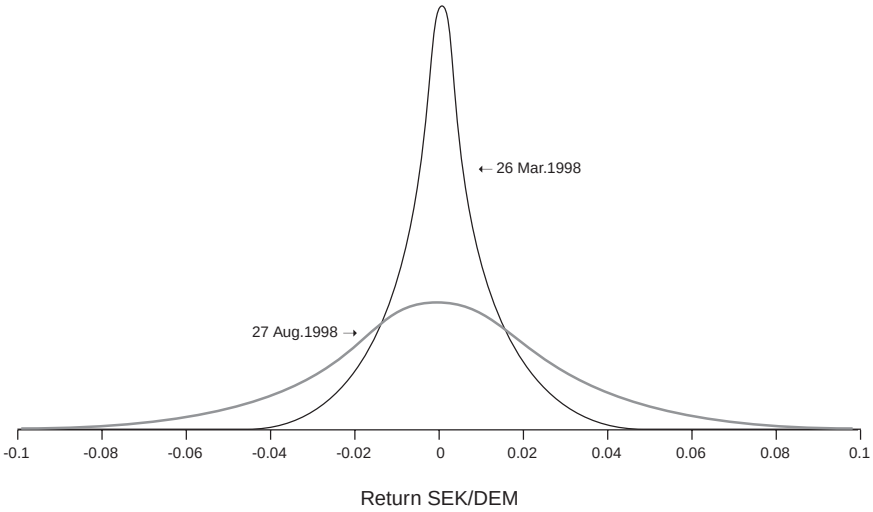
Moment	Oct. 5, 1998	Jan. 15, 1999
Standard deviation	0.15	0.14
Skewness	0.36	–0.34
Kurtosis	0.43	0.60

Table 2 contains the estimated moments of the implied probability distributions, which show that the skewness switched from positive in October 1998 to negative in January 1999. On both occasions, the degree of kurtosis was positive, which indicates that in October 1998 as well as in January 1999, the probability of major movements in the foreign exchange market was considered to be relatively high. Despite the change in assessment of the direction of risk, the expected standard deviation was nearly identical on both dates.

Another interesting case is the market's change in assessment of the SEK/DEM exchange rate during 1998. Chart 9 shows the estimated SEK/DEM distributions on March 26, 1998 and August 27 the same year, derived from one-month options. On the first date of estimation, the krona had strengthened for a while, and the implied distribution shows the market perceived uncertainty to be relatively small. This follows since the standard deviation of the March 26 distribution is low, i.e. the distribution is "compressed". In contrast, the estimated implied distribution for August 27, 1998 has a substantially higher standard deviation, resulting in a distribution that is more "dispersed". At the time being, financial markets were turbulent as a result of Russia's difficulties in repaying its loans. The Swedish krona depreciated sharply, since investors moved their assets to larger currencies. Consequently, the market perceived future developments as very uncertain, which is also evident from the implied distribution in Chart 9.

[25] A positive return means a higher exchange rate, i.e. a weaker krona.

Chart 9. Implied probability distributions for SEK/DEM, March 26, 1998 and August 27, 1998



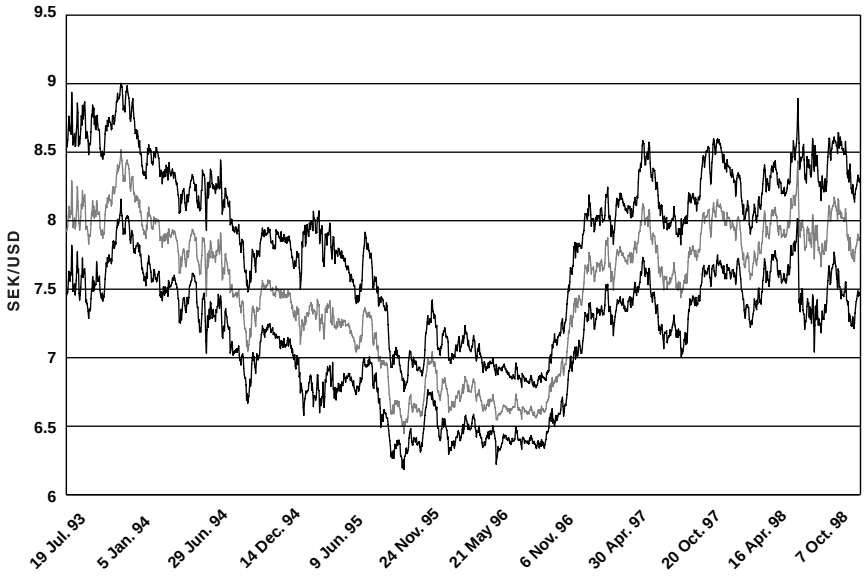
Estimates of implied distributions provide snapshots of market expectations on specific dates. It is also interesting to study how the market's assessment of uncertainty has varied over time. This can be done, for example, by examining the mean of the implied probability distribution[26] relative to a confidence interval. The interval is chosen in such a way that a pre-determined percentage of the mass of the probability distribution, for example 90 per cent, lies within the limits of the interval. This can be interpreted as the interval within which the market believes that the exchange rate will end up in at the end of the forecast horizon, with a 90 per cent probability. A time series of this interval therefore provides an indication of the degree of uncertainty in the currency market over time. When the interval is wide, there is considerable market uncertainty about the future exchange rate. On the other hand, when the interval is narrow, the market is relatively certain of the exchange rate development in the future.

During turbulent periods in the foreign exchange market, the pricing in the options market tends to reflect growing uncertainty about the future.

Chart 10 shows the estimated mean (i.e. the forward exchange rate) one month ahead for SEK/USD, and the 90 per cent confidence interval for the period July 19, 1993–February 10, 1999. The chart clearly shows that uncertainty in the foreign exchange market varies over time. During turbulent

[26] As previously mentioned, the mean is always equal to the forward price, since the implied distributions are risk-neutral.

Chart 10. Estimated mean and 90 per cent confidence interval for SEK/USD, July 19, 1993–February 10, 1999. One month forecast horizon



periods in the foreign exchange market, the pricing in the options market tends to reflect growing uncertainty about the future. This pattern is especially clear during the "Tequila crisis" of late 1994 and early 1995. The chart also indicates that the degree of uncertainty was regarded as relatively high during the latter part of 1997, at the time of the Asian crisis, as well as during the Russian crisis of late summer and early autumn 1998.

Finally, it may be worth noting that the estimated distributions, like all empirical results, are dependent on the quality of the input data. As mentioned earlier, the number of observed option prices is important for the reliability of the results. Of equal importance is the liquidity of the options market. For instance, if trading in certain out-of-the-money options is thin, the risk is great that the estimates will be based on option prices that do not reflect the true market situation. This, in turn, may distort the results and lead to the wrong conclusions.[27]

[27] See Bahra (1997) for a further discussion on these issues.

Facts: "Strangle" and "risk reversal"

By studying certain option prices that are continuously quoted in the OTC market, it is possible to obtain an indication of the shape of the implied probability distribution, without having to estimate it. In this way, one can also quickly form an opinion of market expectations. In the OTC currency option market, combinations of an out-of-the-money call option and an out-of-the-money put option are common. Two very common combinations of this type are called *strangle* and *risk reversal*. It turns out that there is a clear relation between the price of these combinations and the shape of the implied probability distribution.

If we buy a strangle, we buy an out-of-the-money-call as well as an out-of-the-money put option. The holder of a strangle believes there will be large price movements during the life of the options, since the price of the underlying asset must either rise sharply in order for the call option to be exercised, or fall sharply in order for the put option to be exercised. Thus, the direction of the exchange rate movement is irrelevant, as long as there is a large movement in one direction. Consequently, the higher the probability of extreme exchange rate movements is perceived to be, the higher the price one should be willing to pay for a strangle. In other words, the price of a strangle provides an indication of the market's assessment of the degree of kurtosis in the underlying distribution.

In a risk reversal an out-of-the-money call option is exchanged for an out-of-the-money put option.[28] The market participants involved in a risk reversal have a strong perception of the future direction of the underlying exchange rate. An investor who buys a risk reversal believes that it is more probable that the call option will end up in the money than that the put option will do so. In other words, the investor believes that the probability of positive returns in the underlying exchange rate is greater than the probability of negative returns. That is, he believes that the probability distribution is positively skewed. A positive price on a risk reversal means that the out-of-the-money call option is valued higher than the out-of-the-money put option by the market as a whole, therefore indicating that the implied distribution has positive skewness. Hence, the price of a risk reversal provides an indication of the market's perception about the direction of uncertainty.

Summary

For market participants as well as central banks, it is important to form an opinion of market expectations concerning the future development of various economic and financial variables. There is a large number of forecasting methods that are used to predict the level of e.g. financial prices. Since the result is usually a point estimate of the expected future value, it may be difficult to assess the degree of uncertainty associated with the forecast. Furthermore, it is possible that the market does not view the risk to be symmetric around the expected value. In general, this characteristic is not captured by ordinary forecasting models either.

[28] A risk reversal is quoted as the volatility difference between an out-of-the-money call option and an out-of-the-money put option.

This article described how option prices may be used to extract the market's estimate of the probability distribution for future asset prices. These implied probability distributions provide an indication of the market's assessment concerning the uncertainty of future events. In the article, we illustrated the usefulness of this indicator for different types of asset prices. The examples we presented show that the market's assessment of the risk for a given asset may vary substantially over time. In addition, there exist sizeable asymmetries in the market's perception of the future probability distribution. One interesting question for future studies is whether these characteristics of the implied distributions systematically affect the expected return on the underlying asset, for example in the form of various risk premia.

Appendix 1: Estimation of implied distributions with a mix of lognormal distributions[29]

In general, a European option can be priced using *risk-neutral valuation*. According to this method, the option price can be expressed as the present value of the option's expected future pay-off, where expectations are taken with respect to the *risk-neutral probability distribution*.[30] At time t, for example, the price of a European call option, c, with expiration date T and exercise price X, written on an underlying asset S, can be written as

$$c = e^{-r(T-t)} \int_{X}^{\infty} q(S_T)(S_T - X) dS_T \tag{1}$$

where $e^{-r(T-t)}$ is the discount factor based on the risk-free interest rate r, and $q(S_T)$ denotes the risk-neutral density function for the price of the underlying asset on the expiration date. Equivalently, for a European put option:

$$p = e^{-r(T-t)} \int_{0}^{X} q(S_T)(X - S_T) dS_T \tag{2}$$

It is now apparent that by using observed option prices, we should be able to extract the market's estimate of the probability distribution $q(S_T)$ using the two equations above.

[29] See Melick and Thomas (1997) for a more detailed discussion. See also Söderlind and Svensson (1997).

[30] This can also be expressed as taking the expected value with respect to the risk-adjusted probability measure, or *martingale measure*.

Assume that a mixture of two lognormal distributions is suitable to describe the underlying distribution for (S_T):

$$q(S_T) = \theta L(\alpha_1, \beta_1, S_T) + (1-\theta)L(\alpha_2, \beta_2, S_T) \tag{3}$$

$$L(\alpha_i, \beta_i, S_T) = \frac{1}{S_T \beta_i \sqrt{2\pi}} \exp\left(-\frac{(\ln S_T - \alpha_i)^2}{2\beta_i^2}\right), \; i = 1, 2 \tag{4}$$

where α_i and β_i are location and dispersion parameters for each lognormal distribution, which determine the mean and the variance of the distributions according to:

$$\mu_i = \exp\left(\alpha_i + \frac{\beta_i^2}{2}\right) \tag{5}$$

$$\sigma_i^2 = \exp(2\alpha_i + \beta_i^2)(\exp(\beta_i^2) - 1) \tag{6}$$

and where θ is the weighting parameter that determines the relative influence of the two lognormals on the terminal distribution.

Using at least five simultaneously observed call and put option prices with the same maturity but with different exercise prices, the parameters $\{\alpha_1,\alpha_2,\beta_1,\beta_2,\theta\}$ can be estimated by minimising the sum of squared deviations between observed prices, c_j^*, p_j^* and the equivalent theoretical prices, c_j, p_j:[31]

$$\min_{\{\alpha_1, \alpha_2, \beta_1, \beta_2, \theta\}} \sum_{j=1}^{m} (c_j - c_j^*)^2 + \sum_{j=1}^{n} (p_j - p_j^*)^2 \tag{7}$$

As Bahra (1997) suggests, further information can be exploited by including the forward price as an additional observation in the minimisation problem. In the absence of arbitrage opportunities, the forward price will be equal to the mean of the risk-neutral distribution $q(S_T)$:

$$F(t, T) = \theta \exp\left(\alpha_1 + \frac{\beta_1^2}{2}\right) + (1-\theta)\exp\left(\alpha_2 + \frac{\beta_2^2}{2}\right) \tag{8}$$

[31] The option and forward data used in the article consist of the average of bid and ask prices. At any given time, there are usually 20–30 OMX options quotes with different exercise prices but the same maturity. The number of Eurolira options is usually somewhat lower.

The square of the difference between the right-hand and left-hand side in (8) is therefore added to the minimisation problem (7).

In practice, the minimisation problem is substantially simplified since there exist closed-form expressions for the option prices in (1) and (2). OMX Index options are normally priced using Black's (1976) option pricing formula, which uses the forward contract as underlying asset, since index options are often hedged using the forward contract instead of the underlying equities.

Chart 11 shows an example of an estimated implied distribution for the OMX Index with the two weighted lognormal distributions which form the implied distribution.

Finally, Charts 12 and 13 show that the estimated implied distribution is successful in pricing call and put options. This is clear since the difference between theoretical prices (continuous curve) and observed market prices (dots) is small.

Chart 11. Implied distribution of the OMX Index on August 28, 1998, according to option prices as of June 9, 1998, plus the two components that form the implied distribution

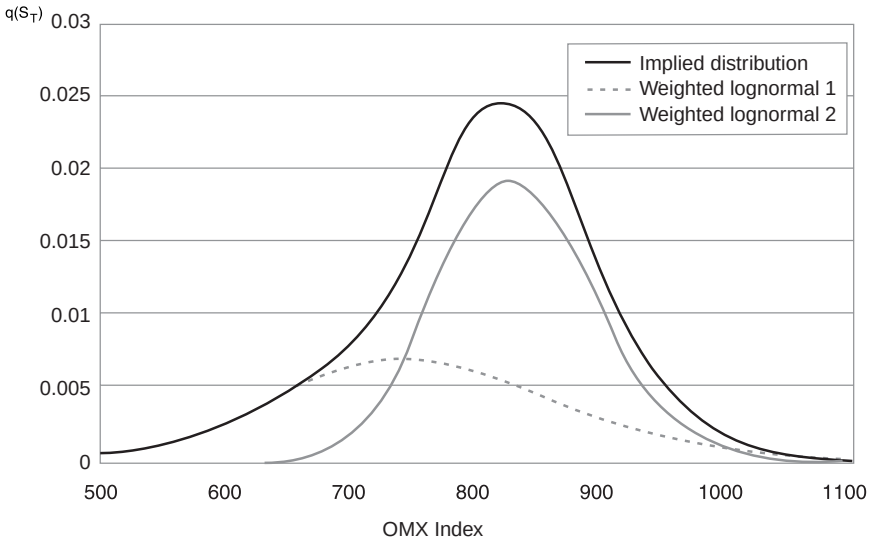


Chart 12. Theoretical and observed prices of OMX call options expiring in August, according to option quotes on June 9, 1998

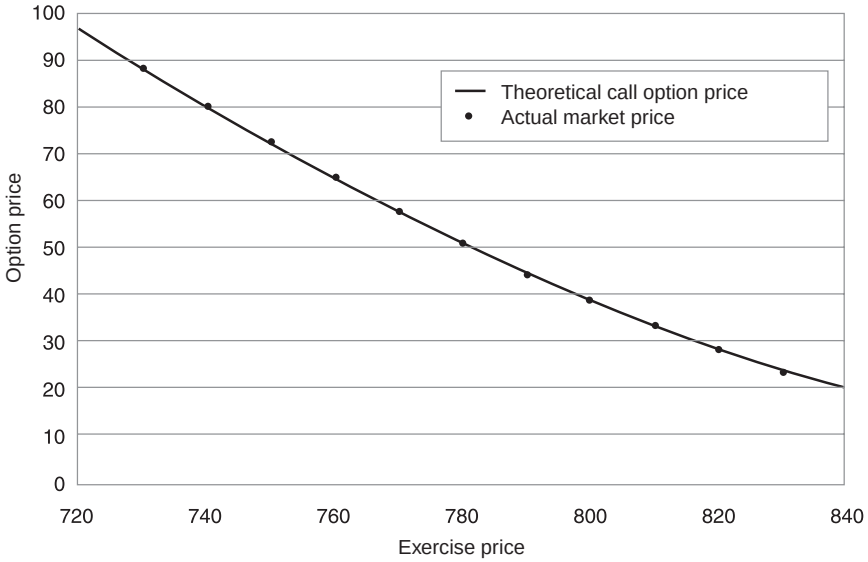
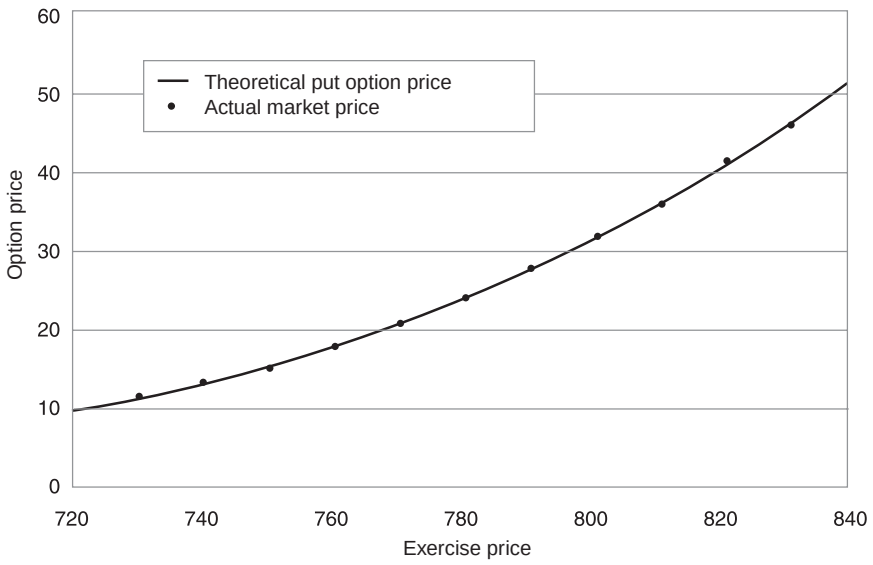


Chart 13. Theoretical and observed prices of OMX put options expiring in August, according to option quotes on June 9, 1998



Appendix 2: Estimation of implied exchange rate distributions

As mentioned earlier, the OTC currency options market provides prices for at-the-money options as well as for strangles and risk reversals. Using three simultaneously quoted option prices, the Malz (1997) method allows us to derive the implied probability distribution for a given exchange rate. This appendix provides a brief description of the method. For further details, see the original article by Malz (1997).

According to Black and Scholes (1973), the price of a call option at time t may be expressed as follows:[32]

$$c = e^{-r(T-t)}\left\{F_T\Phi\left[\frac{\ln\left(\frac{F_T}{X}\right)+\frac{\sigma^2}{2}(T-t)}{\sigma\sqrt{(T-t)}}\right]-X\Phi\left[\frac{\ln\left(\frac{F_T}{X}\right)-\frac{\sigma^2}{2}(T-t)}{\sigma\sqrt{(T-t)}}\right]\right\} \qquad (1)$$

where T is the expiration date of the option, r is the domestic interest rate, F is the forward exchange rate, X is the exercise price and $\Phi[\cdot]$ denotes the standardised cumulative normal distribution. The rate of change of the option price with respect to changes in the exchange rate S is called the delta value of the option and can be expressed as follows:

$$\delta_c = \frac{\partial c(\cdot)}{\partial S_t} = e^{(r-r^*)(T-t)}\frac{\partial c(\cdot)}{\partial F_T} = e^{-r^*(T-t)}\Phi\left[\frac{\ln\left(\frac{F_T}{X}\right)+\frac{\sigma^2}{2}(T-t)}{\sigma\sqrt{(T-t)}}\right]. \qquad (2)$$

Delta, which is between 0 and 1 for call options, therefore measures the degree of *moneyness*, i.e. how deep in- or out-of-the-money the option is.

In the OTC market, at-the-money options (which have $\delta = 0.5$) are quoted directly in terms of implied volatility (*atm*). A strangle (*str*) is quoted as the difference between the average volatility of out-of-the-money options (with $\delta = 0.5$) and the at-the-money volatility. A risk reversal (*rr*) is quoted as the difference between the volatility of out-of-the-money call and put options, respectively.

[32] This expression is given by substituting the forward exchange rate into the Black-Scholes (1973)/Garman-Kohlhagen (1983) formula, $F_T = S_t e^{(r-r^*)(T-t)}$, where r^* denotes the foreign interest rate and S is the price of the underlying asset.

One characteristic of currency options is that an SEK/USD call option, for example, with a certain exercise price is identical to a USD/SEK put option with (the inverse of) the same exercise price. This means that the implied volatility of a 0.25 delta put option must be identical to the implied volatility of a 0.75 delta call option. Consequently, a strangle can be expressed as follows:

$$str = 0.5(\sigma^{0.75\delta} + \sigma^{0.25\delta}) - atm \tag{3}$$

due to the way the strangle is quoted. Similarly, the price of a risk reversal can be expressed as

$$rr = \sigma^{0.25\delta} - \sigma^{0.75\delta} \tag{4}$$

The volatility smile can then be derived by fitting the following function to the observed market prices:

$$\sigma(\delta, atm, rr, str) = a_0 \cdot atm - a_1 \cdot rr(\delta - 0.5) + a_2 str(\delta - 0.5)^2 \tag{5}$$

In this simple function, *atm* will state the general level of the volatility smile, while the skewness of the smile is determined by the value of *rr*, and its curvature is determined by the value of *str*. The parameters can be derived easily, by ensuring that the smile function (5) always passes through the observed quotes for *atm*, *rr* and *str*. Since $\delta = 0.5$, for the *at-the-money* volatility, a_0 can be set to 1, because

$$atm = a_0 \cdot atm - a_1 \cdot rr(0.5 - 0.5) + a_2 str(0.5 - 0.5)^2 \tag{6}$$

In the same way, we can set $a_1 = 2$, since

$$rr = \sigma^{0,25\delta} - \sigma^{0,75\delta} = \sigma(0.25; atm, rr, str) - \sigma(0.75; atm, rr, str) = a1 \cdot rr(0.5) \tag{7}$$

Finally, we can set $a_2 = 16$, since

$$\begin{aligned} str &= \frac{\sigma^{0.25\delta} + \sigma^{0.75\delta}}{2} - atm \\ &= \frac{\sigma(0.25; atm, rr, str) + \sigma(0.75; atm, rr, str)}{2} - atm \\ &= 0.25^2 a_2 \cdot str \end{aligned} \tag{8}$$

Thus, the volatility smile function can be expressed as follows:

$$\sigma(\delta, atm, rr, str) = atm - 2rr(\delta - 0.5) + 16str(\delta - 0.5)^2 \qquad (9)$$

If we substitute the delta function (2) into the volatility smile function (9), we obtain the following implied function:

$$\sigma = atm - 2rr\left\{e^{-r^*(T-t)}\Phi\left[\frac{\ln\left(\frac{F_T}{X}\right) + \frac{\sigma^2}{2}(T-t)}{\sigma\sqrt{(T-t)}}\right] - 0.50\right\} + 16str\left\{e^{-r^*(T-t)}\Phi\left[\frac{\ln\left(\frac{F_T}{X}\right) + \frac{\sigma^2}{2}(T-t)}{\sigma\sqrt{(T-t)}}\right] - (0.50)\right\}^2 \qquad (10)$$

Finally, the above volatility function is substituted into the Black-Scholes formula (1), and the probability distribution is derived by taking the second derivative of the result with respect to X and multiplying by $e^{r(T-t)}$.[33]

[33] This follows from the well-known result by Breeden and Litzenberger (1978).

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Managing and Preventing Financial Crises – Lessons from the Swedish Experience

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In the early 1990s, Sweden went through a severe banking crisis. This paper gives a short presentation of how the crisis developed and how it was managed. We then discuss what lessons can be learned from the crisis. We also review the measures that have been taken since the crisis to reduce the risk of future banking crises and to handle the various phases of a banking crisis should one occur.

The Swedish Banking Crisis in the early 1990s

Characteristics of the crisis[1]

The banking crisis was one ingredient in a general economic crisis in Sweden.

The banking crisis was one ingredient in a general economic crisis in Sweden and it is relatively easy to see what made it erupt. During the 1980s, the process of full deregulation of the Swedish financial markets took place. At the time it was undertaken, the Swedish economy was experiencing a protracted economic upswing. This led to high investment, especially in the real estate sector where prices skyrocketed. Due to the earlier restrictions on borrowing there was a strong pent-up demand for credit. The increasing demand for credit was exacerbated by a tax system that favoured

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[1] A description of the Swedish banking crisis in English can be found in Burkhard Drees and Ceyla Pazarbaşioğlu "An overview of the Swedish banking crisis, Pitfalls in Financial Liberation?," *Occasional Paper 161* IMF 1998.

borrowing instead of saving especially in times of high inflation. The deregulation of financial markets led to increased competition between banks. Bank management lowered credit standards in their struggle for larger market shares. Banks entered into this competition despite the fact that they were unfamiliar with doing business in a deregulated environment and lacked adequate knowledge and procedures to make proper credit assessments. Nor did the Financial Supervisory Authority (FSA) have the competence and the instruments to make assessments of the financial risks and other important developments in credit institutions. The volume of credits expanded rapidly from 1985 to 1990. A large part was lent to investors in housing or commercial real estate and most of it was collateralised by real estate, thus concentrating a large share of risk to this sector.

The mismatch of maturities in loans and funding in foreign currencies exposed banks to large liquidity risks.

In the early 1990s, interest rates were historically high. Swedish monetary policy with its target of a fixed exchange rate, first towards a currency basket and from 1991 against the ECU, contributed to the upward pressure on interest rates. Given the high level of nominal interest rates for Swedish krona loans, a large segment of borrowers preferred to denominate their loans in low-interest currencies, such as the Deutsche Mark. Banks funded loans denominated in foreign currencies mainly in the international interbank market. These funds were predominantly short-term, whereas the lending was partly medium- or long-term. The mismatch of maturities in loans and funding in foreign currencies exposed banks to large liquidity risks.

A number of events that took place around the year 1990 set the stage for the ensuing crisis. The strong economic cycle ended and turned into a sharp recession with negative growth rates for three consecutive years. The recession coincided with a milder downturn in the international economy, which in turn weakened the demand for Swedish exports. The unemployment rate increased drastically as a result. Property prices plunged by more than 50 per cent over a period of only 18 months. At this time the major political parties agreed on a tax reform that favoured saving and sharply reduced the incentives to borrow. The government supported a strong and successful anti-inflationary stance. The combination of new tax laws, high nominal interest rates and low inflation lifted real interest rates to levels unimaginable a few years earlier.

The risk for a credit crunch became real.

Credit losses in the banking system began to accumulate rapidly, and during the summer and autumn of 1992, the situation grew worse. The recession combined with the rapid depreciation of real estate prices

caused big losses for banks and other financial institutions (institutions that in most cases were owned by banks and therefore caused even bigger losses for the banks). The European currency crisis in 1992 forced the Riksbank to hike the short-term interest rates, and the depreciation of the Swedish krona following the abandonment of the fixed exchange rate policy in November 1992 led to a rapidly deteriorating situation in the financial markets. Many borrowers had debts in foreign currencies – debts whose values in one day rose to uncontrollable levels. Foreign lenders cut their credit lines to Swedish banks. This created a shortage for liquidity and foreign currencies within the financial system. The risk for a credit crunch became real.

In the late summer of 1992, the threat of a systemic crisis was evident. The seven largest banks, which accounted for approximately 90 per cent of the banking market, all had serious problems in their loan portfolios. The credit losses of these banks during the crisis amounted to 12 per cent of the Swedish GDP. Six of these seven banks needed more capital from their owners or from the government.

How the crisis was managed[2]

During the autumn of 1992, the Ministry of Finance (MoF) together with the Riksbank and the Financial Supervisory Authority (FSA) decided that the following actions were the highest priorities:

– Restore confidence in the financial system.
– Attain political consensus about the necessary actions.
– Organise and divide the work.

The official guarantee from the government to depositors and other counterparts of the Swedish banks laid the foundation for renewed confidence in the financial sector.

The official guarantee[3] from the government to depositors and other counterparties of the Swedish banks laid the foundation for renewed confidence in the financial sector. No limit was set on the amount of the guarantee in order to minimise the political cost of renewed petitions for government support in later phases of the crisis. Moreover, the Riksbank transferred parts of its reserve of foreign currencies to the banking system to avoid a credit crunch. Further actions to restore the confidence were information to the financial markets, especially the international market, about the guarantee and the steps to be taken by the government.

[2] For a more detailed description see: Stefan Ingves and Göran Lind, "The management of the bank crisis—in retrospect," *Quarterly Review*, 1996:1 Sveriges Riksbank pp. 5–18.
[3] At the time of the bank crisis there was no deposit insurance scheme in Sweden.

To attain a political consensus the government kept the opposition informed and let the opposition give their views on the proposed actions. The opposition was also represented in the Bank Support Authority (see below).

It was obvious that the crisis was too large to be handled by the MoF. The Riksbank and the FSA were considered not to be the proper authorities to manage the crisis. The solution was to create a new separate organisation, the Bank Support Authority (BSA), governed by the MoF.

When the organisation of the BSA was in place, the next challenge was to find the best method for providing the support. The banks that had applied for support, that is to say all the major Swedish banks except Svenska Handelsbanken, had to report their real and expected credit losses, suspended interest rates payments, liabilities and securities to the BSA. The method for providing the support was based on these figures. The main purpose was to choose the form of support that was most efficient and cheapest for the economy and society as a whole. A balance was maintained between using a minimum of government funds and providing the bank with adequate capital. The best way of striking that balance was by providing part of the support in the form of guarantees. If the capital ratio fell below a certain threshold, the guarantee would be converted into loans or equity capital. One important question was the risk for moral hazard. To reduce that risk, it was decided that in cases where the government supported a bank with capital, the owners would loose an amount of money equivalent to the capital from the government. In order to reduce uncertainty concerning the bank's future, it was decided that the majority of its bad loans and assets would be transferred to some form of asset management company (AMC) not owned by the bank.[4] The idea was that the specialised management of loans would probably lead to a higher degree of loan-loss recoveries.

The fundamental paradigm guiding the support operations was the so-called hammock approach.

The fundamental paradigm guiding the support operations was the so-called hammock approach. This was a common yardstick according to which the banks' need of support and additional measures could be analysed. The objective of this model was to anticipate each bank's economic strength in terms of its earning capacity and capital buffer. All financial information obtained from banks and from other

[4] The functioning of these asset management companies is described in Stefan Ingves and Göran Lind, "Loan Loss Recoveries and Debt Resolution Agencies: The Swedish Experience," in *Bank Soundness and Monetary Policy*, Charles Enoch and John Green eds. IMF 1997 pp. 421–448, and Göran Lind, "The use of asset management corporations in the Swedish Crisis," World Bank and Monetary Authority of Singapore Conference on Global Lessons in Banking Crisis Resolution for East Asia, May 1998.

sources, including macroeconomic data and forecasts, was fed into this computer-based forecasting model. This model could then produce an estimate of the bank's likely financial development over the next three to five years. The result of the analysis would be used to divide the banks in different groups, designated as A-, B- and C-banks, depending on their potential for profitability in the short and medium term. In the next stage the forecasts were used to decide the amount of financial support that a bank qualifying for support needed. The guiding principle in this context was that the restructuring of the bank sector should preserve a satisfactory level of cost efficiency and competition.

The guiding principle was that the restructuring of the bank sector should preserve a satisfactory level of cost efficiency and competition.

An A-bank was a bank that was forecasted to overcome its current problems and show a profit within the medium term. Its capital base would probably decrease, but stay above the required level of 8 per cent. The problems in these banks could be solved by capital infusions from the owners. An example was S-E-Banken, which never received any direct support from the government.

The B-banks were, like the A-banks, profitable in the medium term, but the temporary problems were more serious. The capital could be expected to decrease below 8 per cent for a limited period of time. The B-banks were deemed to need capital from their owners together with guarantees from the government. According to the design of the latter, if the capital ratio fell below the required ratio, the guarantee would be converted into loans or equity capital. The guarantees were necessary so that the owners would be willing to take the risk of buying new shares. Also, as mentioned above, a majority of B-banks' non-performing loans and assets were transferred to the AMC in order to facilitate a more efficient handling of the "good" and "bad" parts of the bank. An example of a B-bank was Föreningsbanken (The Cooperative Bank), which in the end managed to survive without any financial aid from the government.

C-banks were those with no future prospects, not even after official support or reconstruction. Capital was on its way down to and below zero. Those banks were to be closed or merged with other stronger banks depending on which alternative incurred with the lowest cost for the society as a whole. An example of a C-bank was Gota Bank. The bad loans in Gota Bank were transferred to a new company – Retriva – and the rest of the bank was put up for auction and later merged with Nordbanken. By separating the bad loans from the remaining sound parts of the bank, it was possible to get a higher price.

A number of foreign consulting firms were engaged with the task of providing the competence and expert knowledge on the management of bank crises that

was needed at this juncture. These consultants had gained competence in these issues through earlier experiences with bank crises in the USA and Norway. The tasks were divided among them in order to avoid a situation in which any of these consultants gained too much influence. One of these firms helped the MoF and the BSA in analysing banks' loans and other assets and separating the sound ones from the non-performing ones. Other firms did the work of analysing banks' risk management systems, and still others analysed their strategies and efficiency levels. The result of this analysis was an important input in the design of adequate bank support measures.

The remaining banks in the banking system in Sweden recovered from the crisis within a couple of years.

The remaining banks in the banking system in Sweden recovered from the crisis within a couple of years. As early as 1993, the owners in both S-E-Banken and Sparbanken Sverige agreed to put in more money in the banks, and the banks managed to fulfil the capital requirement of 8 per cent. After 1993, there were no further commitments from the BSA, and in 1994 the banking system as a whole showed a profit.

The total amount of commitments by the BSA during the crisis was 88 billion SEK, but the total amount actually paid by the BSA to the banks was 65 billion. Most of that money, however, has been paid back to the government through dividends, selling of shares, and the value of retained shares.

What can be learned from the banking crisis?

In the discussion of the lessons to be drawn from the Swedish banking crisis we identify three different crisis "phases": the building-up phase, the phase of acute payment system risk and the crisis management phase. For each phase we try to draw on the experiences from the crisis and discuss the measures that have been taken or are planned to reduce the risk for future crises and to mitigate the consequences, should a crisis actually erupt.

Phase one – the building up of the crisis

The *first* phase is the building up of a financial crisis. An examination of the Swedish banking crisis, like other banking crises in the world, reveals a number of factors that contribute in a rather complicated way to triggering the crisis development. One factor stands out, however, as crucial, and that is the consistency and credibility of macroeconomic policy. Here, macroeconomic policy should be interpreted in a broad sense not to include just conventional stabilisation policy.

One should rather look for the consistency and longer-term viability of various policy regimes concerning for instance fiscal and monetary policy. It is also important to analyse how these policy regimes conform to the general developments in the real and financial sectors of the economy.

It seems clear that the building up of the Swedish financial crisis could have attracted attention at an earlier stage.

In hindsight, it seems clear that the building up of the Swedish financial crisis could have attracted attention at an earlier stage and perhaps have led to a less severe course of events. One basic problem with the macro-policy mix in Sweden at that time was the choice of monetary policy regime. As mentioned, the Swedish currency was pegged to a basket of currencies within a fairly narrow band. With lax fiscal policy, the burden for the defence of the krona was entirely borne by monetary policy. During the crisis there was clearly a conflict between the price stability (through the exchange rate target) and financial stability goals of the central bank. To defend the krona, interest rates had to be raised, in the end to astronomical heights. This naturally hit the already problem-stricken banks hard and contributed to the acceleration of the crisis.

It is interesting to compare the crisis regime with the current inflation target regime. In the current regime, the above-mentioned policy conflict is basically eliminated. In a situation where the payment system is threatened with collapse, a lowering of interest rates would be appropriate not only for financial stability reasons but also to avoid deflationary tendencies in the economy.

Looking back at the Swedish financial crisis it is also clear that neither the banking sector nor the supervisory authorities were prepared.

Looking back at the Swedish financial crisis it is also clear that neither the banking sector nor the supervisory authorities were prepared to handle the new situation caused by the rapid deregulation of the financial system. It is easy to understand, although difficult to accept, that both banks and supervisory authorities entered this new world without paying much attention to risk management and risk control issues. Seen from the point of view of the regulatory authorities even a rudimentary evaluation of the development of for instance the loan portfolios in banks and other financial institutions should at least have revealed the lack of consistent risk analysis in loan decisions and the tensions created by the rapid and biased expansion of loans to certain sectors, in particular the real estate sector.

One has to be careful in making too much of the fact that in retrospect there seems to have been a number of indicators that should have given early warnings about what was building up in the financial sector. Still we should try to learn

from the mistakes of ignoring these early warning signals and try to use the experiences from the crisis in the search for better methods to detect and handle crisis phenomena at an early stage.

Recent work aimed at reducing the risk that future financial crises will be allowed to develop to proportions like the recent one can be divided into two categories. *First*, the Riksbank and the FSA have been working systematically on building up an analytical framework, through which relevant macroeconomic and financial sector data and information are regularly evaluated with the purpose of making judgements about the health of the Swedish financial system. A major product of this effort is the *Financial Market Report* that disseminates the Riksbank's analysis of the financial system. *Second*, a major revision of the regulatory and legislative framework for the financial sector is underway. This work focuses particularly on the banking sector and includes the supervisory activities based on this regulation.

The analytical framework of the Riksbank

The financial crisis made it clear that the Riksbank needs to put as much emphasis on its goal of preserving financial stability as it does on its price stability goal.

The financial crisis made it clear that the Riksbank needs to put as much emphasis on its goal of preserving financial stability as it does on its price stability goal. This has meant clarifying the Riksbank's role as overseer of the payment system, establishing the areas of emphasis for gauging financial stability and publishing the Riksbank's views on developments in the financial markets in a biannual publication, the *Financial Market Report.*

The *Financial Market Reports* are public reports with the general purpose, as stated by the Governor, to regularly comment on the Bank's views about the stability conditions in the financial sector. Since one of the Riksbank's two main tasks (The other is of course price stability.) is to promote a stable and efficient payment system, it is considered natural for the Bank to give reports on developments in this area for much the same reason as Inflation Reports are a natural and important ingredient in the Bank's inflation policy. With these reports the Riksbank also aims to encourage debate about topics related to financial markets while providing relevant information and methods of analysis to policy makers, the public, the media and participants in the financial markets. This approach reflects the Riksbank's general appraisal of the benefits derived from openness and transparency in policy making. The response to this report has been positive. It

has already proved to be a valuable conduit for communicating the Riksbank's concerns to those active in the financial arena.

These reports are an organic part of the Riksbank's analysis of financial markets. The starting point for this analysis was constructing a working definition of the Riksbank's role as overseer of the financial system. The Riksbank, like many central banks, has the responsibility for financial stability but not for supervision. The Riksbank Act describes this responsibility as the goal of promoting a safe and efficient payment system. The operationalisation of the oversight role was built up from insights gained in operating the central payment system and providing liquidity to banks as part of payment system and monetary policy operations. The oversight responsibility of the Bank also encompasses the analysis and techniques essential for the role as lender of last resort when the central bank provides liquidity in exceptional circumstances.

It became clear that it was necessary to try to identify the threats to the system by analysing the stability of the banking sector.

Banks and the payment system infrastructure are very closely linked to each other. Even though the central bank has the primary objective of promoting the efficiency and stability of the payment system, ensuring a smoothly operating and well designed system is not enough. For some years, the Riksbank had tried to ensure that the infrastructure would be able to withstand any disturbances that could occur in the system. However, it became clear that it was necessary to try to identify the threats to the system by analysing the stability of the banking sector, with special emphasis on the major banks.

Analysis could be used as a possible early indicator of excess risk taking in the banking sector.

The analysis of banking system stability is based on three parts. *First* there is the analysis of profitability and efficiency. If the banking system is not profitable there is a risk that banks will try to increase their risk exposure in order to show at least in the short term a better return on equity. In inefficient banking systems, history has shown that there is a risk that banks do not have the proper incentives to manage their risk taking in a prudent way. In both these situations the analysis could be used as a possible early indicator of excess risk taking in the banking sector, which in the longer run could lead to financial fragility.

Second is the analysis of the banking system's credit risks. In evaluating bank lending and comparing it to the macroeconomic development, important insights can be gained about the stability in the banking sector. This part of the analysis focuses on different categories of loan takers' ability to pay back their loans. The main categories are the household and corporate sectors. In the latter, the real es-

tate sector receives special attention because of the substantial exposure that banks have towards this sector. In the past the real estate sector has been the source of large credit losses for banks.

The *third*, and last, part of the banking stability analysis is the counterparty and settlement risks. In this, the analysis of the banking firms and the payment and clearing systems are combined. A bank run of today will most certainly come from the international interbank market. Banks are becoming more and more dependent on other financial institutions in their trading and financing activities. Very large exposures towards liquidity and credit risks are built up in the FX and bond trading, for example. The extent of these risks depends on the creditworthiness of the counterparties but also on settlement procedures.

A deterioration of credit quality will almost certainly affect all banks.

A combination of these three parts of the analysis of the banking sector provides a good picture of the overall stability in the financial system. One can argue that operational and market risks should be included as well. However, these are mainly bank specific risks, which are being supervised in detail by the FSA. Even if one major institution were to face severe problems caused by exposure to these risks, this would not lead to a systemic crisis if counterparty risk, both liquidity risk and credit risk, were to be managed properly. A deterioration of credit quality, on the contrary, will almost certainly affect all banks, even though their respective risk management systems will make the difference on how they will be affected (as shown by the previous crisis).

The new legislative framework

As explained above, another lesson from the banking crisis was the need to review the legislative framework. A government committee was given the task of carrying out this review by examining and suggesting amendments to the legislation regulating banks and other financial institutions. As part of its work, the Committee is also directed to suggest methods for the supervisory implementation of the new legislation. The general purpose of the Committee work as stated in its directives is to build up a framework that could help reduce the probability of a financial crisis occurring in the future.

The main report of the Committee[5] has recently been published and was presented to the government. A brief account of the Committee's general ap-

[5] Reglering och tillsyn av banker och kreditmarknadsföretag (Regulation and supervision of banks and credit market companies). SOU 1998:160.

proach gives an indication of how it fits into the crisis management scheme. It should be noted that the Committee report is a *suggestion* that in the end will lead to a government proposal to Parliament on a new Banking Act.

The Committee in its analysis takes as a starting point a clear identification of the reasons why banks and other financial institutions require special attention from regulators. The main reason why banks are considered especially important is their strategic role in the payment system. In modern payment systems with their rapid expansion of large-value payments, the daily turn-over amounts to astronomic sums, and even the suspicion that one of the major banks is in trouble could cause serious disruptions in the payment system. The contagion effects of a sudden bank failure are potentially very large, and the system instability problem that is inherent here gives the usual "market failure" motivation for state intervention.

Even the suspicion that one of the major banks is in trouble could cause serious disruptions in the payment system.

The Committee makes it quite clear, however, that these interventions must be designed in such a way that the banks can work under competitive conditions and get proper incentives for innovation and product development. The regulatory framework needed to safeguard the stability of the payment system therefore must be set up in such a way that the stability in the banking system can be promoted without unduly hampering the competitiveness of banks. At the same time moral hazard effects of the regulatory framework must be avoided. Bankruptcies in individual banks must be an economic reality faced by all actors in the financial sector. It should be made clear that the bailing out of management and equity owners in crisis-stricken banks is not an alternative.

It should be made clear that the bailing out of management and equity owners in crisis-stricken banks is not an alternative.

From these considerations a couple of basic requirements for the management and status of banks are formulated by the Committee in terms of core paragraphs in the suggested Banking Act.

The *first* core paragraph proposed by the Committee is concerned with the solvency of banks. With a satisfactory capital base a bank would have a buffer against unexpected losses. With a reasonable amount of buffer capital, the incentives of bank managers and shareholders would basically coincide with those of the regulators. The health of the bank would be as much in their interest as in society's. Whether the capital base of a bank can be considered satis-

The Basle capital adequacy rules are minimum standards, which could and should be refined and developed by national authorities.

factory or not depends of course on the risk exposure of the bank. Although this is the main philosophy behind the Basle Accord, it is also well known that the Basle rules in many respects are quite primitive and even in some cases misleading, especially the rules concerning the banking book. The Basle Accord will be updated and modernised, but since this probably will take time, the Committee has taken the view that the Basle capital adequacy rules are minimum standards, which could and should be refined and developed by national authorities.

The *second* general paragraph emphasises the importance of having well developed systems of risk management and risk control in the banks. It goes without saying that risk-based capital adequacy requirements without appropriate risk control systems are an empty shell. Also, one of the pillars of banking business (and that of other financial institutions as well) is controlled risk-taking. To discover that a bank does not have a clear strategy for its risk taking or a clear picture of its risk exposure is certainly an ominous sign.

The *third* main paragraph of the proposed new regulatory framework focuses on the transparency of banks. To make the measurement of banks' capital base and risk exposure meaningful they must be required to have high standards for their reporting and information systems. Business activities in the banking firm cannot be allowed to be too opaque.

The *fourth* main paragraph is an attempt to formulate a standard of good conduct for the banking industry as a whole. This is done in the intention to capture the possible negative externalities caused by a bank, which happens to fulfil the solvency and risk management requirements but whose business methods are considered to endanger the reputation of the whole banking sector.

By necessity the proposed main paragraphs are a bit vague in their formulations. The purpose is that they give as clear as possible a picture of what should be considered the main focus in the regulators' attempt to reduce the risk of a failure in one bank leading to the collapse of the payment system. This should also enhance the possibilities for the supervisory authorities to focus their attention on a major source of risk, systemic instability. The Committee proposes that the supervisory authority get a clear responsibility for implementing the framework given in the above-mentioned main paragraphs. This emphasises that the supervisory authority together with the Riksbank should make judgements on the whole banking and financial system as a summary statement of its investigations into how well the individual banks conform with the regulatory requirements.

It may help bringing concerns about financial stability to the forefront and provide the supervisory authorities with an agenda that is much more clearly focused on that task.

It is worth emphasising that we have spent time on presenting the proposed new banking legislation not because of over-confidence in the formal framework per se but because we think that it may help bringing concerns about financial stability to the forefront and provide the supervisory authorities with an agenda that is much more clearly focused on that task. The legislative and regulatory framework that was in place in Sweden when the crisis broke out was definitely lacking such focus.

Phase two – threats of payment system collapse

What we have discussed so far is the work that is aimed at preventing a crisis. The major focus has been on trying to detect and handle at an early stage tendencies toward macroeconomic inconsistencies that will in the end lead to serious financial disruptions threatening the stability of the financial system. We have also dealt with attempts at following more closely the developments among the most strategic players in the financial system, i.e. the banks. All that work has, however, focused on conditions when the banks (and other financial institutions) are still functioning reasonably well and the requirements set up by the regulators are (seemingly) met. Let us now continue our analysis of what we can learn from the crisis and look at what we have called the *second* phase.

This phase is the short period when problems in the banking sector threaten to develop into a systemic crisis with a collapse of the payment system. It should be pointed out that the vulnerability of modern payment systems lies much more in the member banks' exposure to short-run interbank funding, especially from abroad, than in the traditional retail customer bank run problem. In the Swedish crisis, the imminent risk of a payment system collapse was avoided through the government guarantee. At first glance the only lesson to be drawn from the Swedish crisis experience might then be that the government should be alert and not hesitate to declare that it stands ready to issue a similar guarantee in case of a future emergency. In our view this oversimplifies the lessons from the Swedish crisis. It is true that the Swedish political system showed its capacity for prompt action when the crisis became acute. In many respects, the political situation was a bit special, however. Other crisis symptoms that need not necessarily be part of a banking crisis had created an atmosphere of national emergency of an almost war-like kind. The most spectacular illustration of this was the crisis packages agreed on between government and opposition (the social democrats) to rescue the fixed exchange rate, on which much of the confidence in the declared low-inflation regime seemed to rest.

The imminent risk of a payment system collapse was avoided through the government guarantee.

In the future a banking crisis may very well erupt without other macroeconomic calamities having preceded it.

In the future a banking crisis may very well erupt without other macroeconomic calamities having preceded it (or developing simultaneously). Normally, the decision-making process in democracies is rather slow and often characterised by time-consuming wheeling and dealing, which could be devastating in a financial crisis situation. Since interbank funding can dry up extremely quickly – it could be a matter of minutes, there is very little room for hesitation in crisis situations. A clear mandate to an institution at arm's length from the political process to act as lender of last resort may be a natural alternative. This is of course one of the classical roles assigned to central banks. It has, however, been clearly demonstrated by a number of analysts of modern central banking that the main reasons for assigning a lender of last resort function to central banks were quite different and of little relevance for today's advanced financial systems. Today central banks still provide very short-term (intraday and overnight) lending facilities to banks, but they are typically part of the normal working of the payment system and more or less fully collateralised. These lending activities are performed by central banks not because they have unique access to liquidity, but because they have found it natural to take a leading role in the interbank clearing and settlement system. But in a world of well developed money markets the fully collateralised loans the banks acquire from the central bank could, under normal market conditions, as well be channelled via private institutions. In Sweden the Riksbank Act also contains a paragraph specifying the *lender of last resort* mandate: Under extraordinary circumstances the Riksbank may extend loans to institutions that stand under the supervision of the FSA without requiring full collateral. The spirit of the paragraph is the idea that last resort loans should be given to banks (or other financial institutions of vital importance) which have acute liquidity problems but are basically solvent. This is of course a prescription as easy to formulate as it is difficult to implement.

The consensus view among central bankers seems to be that reliance on general liquidity injections would not be enough in situations where a payment system crisis is imminent.

Some critics of the lender of last resort function have drawn the conclusion that since there is no reason why the central bank knows better than the market which banks are temporarily illiquid and which are basically insolvent, the central bank should abstain from directed loans. It should instead focus on injecting liquidity into the banking system through the ordinary monetary policy channel. Although there are few attempts to show rigorously the need for a lender of last resort role for

central banks[6], the consensus view among central bankers seems to be that reliance on general liquidity injections would not be enough in situations where a payment system crisis is imminent. As mentioned, the time perspective in such a situation is extremely short and the uncertainty among the private actors in the financial system about each other's positions may be so deep that the system gets paralysed. Regardless of how much liquidity the central bank injects into the financial system, it is doubtful that the liquidity will be channelled to those banks, which need it quickly enough to avoid systemic problems. Central bank lending aimed directly at the illiquid banks seems to be the only alternative in the short run to prevent the liquidity problems from quickly developing into insolvency problems.

There also seems to be a consensus that the task of the central bank really is to provide liquidity to the banking system, not to take responsibility for the longer-term financing or even recapitalisation of banks that may turn out to be necessary. Consequently, last resort loans from central banks should clearly be short-term. The basic idea would be that central banks could offer "bridge" loans at short notice and that other sources, ultimately the government if that turns out to be necessary, should come in as soon as the picture gets clearer, allowing the central bank loans to be repaid.

Again, this simple idea is easier to formulate than to put into practice. Not much reflection is needed to see that the question of delegating a lender of last resort role to the central bank cannot be considered in isolation. The lender of last resort function should be seen as one of a number of ingredients in a well-designed crisis management package. In a broader sense, it could also be considered as part of the general safety net that is built around the financial sector, where deposit insurance and regulation and supervision of banks and other financial institutions are other ingredients.

The central bank cannot take on the responsibilities for last resort lending without reasonable knowledge about the health of the banks.

It seems obvious that the central bank cannot take on the responsibilities for last resort lending without reasonable knowledge about the health of the banks that get loan support and of the banking system as a whole. One piece in the information process is the ongoing attempts from the central bank to make judgements concerning the health of the banking system (see Phase one above). A crucial issue here, however, is what measures the central

[6] One interesting example is a paper by Mark Flannery, "Financial Crises, Payment System Problems, and Discount Window Lending", Journal of Money, Credit, and Banking, Vol. 28, No. 4 (November 1996, Part 2).

bank and/or supervisory authority could take when they have detected tendencies toward financial weakness in a bank that might develop into a bank failure with systemic consequences. At the time of the Swedish banking crisis (and this is the case even today) the supervisory authority did not have (nor did the Riksbank) much legal support for any actions going further than declarations about unsound behaviour in the weakening banks. The only really powerful measure at the disposal of the supervisory authority was the withdrawal of the banking licence. The problem with this measure is that it is usually too strong. In impending payment system crises, the threat of using this measure would most certainly contribute to aggravating the crisis.[7]

During the acute phase of the Swedish banking crisis no bank fell under the capital adequacy requirements.

The only clear triggering point was when a bank's capital base dipped under the level required by the capital adequacy rules. Formally, the consequence of such an event should be withdrawal of the licence, if the bank was not promptly recapitalised. On the one hand this would, as mentioned, be too crude a measure to be taken in a delicate situation, on the other hand the capital adequacy measures seem to react with a considerable lag to deterioration in the financial health of a bank. During the acute phase of the Swedish banking crisis, for instance, *no* bank fell under the capital adequacy requirements.

In short, there was not much of a formal framework for the crisis managers to lean on during the acute phase of the Swedish banking crisis. Therefore most actions had to be improvised. With the government guarantee issued in time to prevent a payment system collapse, the lender of last resort function of the central bank was not really tested.[8]

In our view, the regulatory system should be supplemented with a framework that provides a reasonable environment for the lender of last resort function of the central bank. What we have in mind is the creation of a legal basis for some kind of trigger point system. Based on this system, the supervisory authority (in close co-operation with the central bank) can take corrective steps vis-à-vis banks that seem to be entering the danger zone. These actions should include the final removal of the incumbent management. They should also include requirements

[7] In the case of the Riksbank, the only sanction is to exclude a bank from the payment system run by the Bank – the RIX system. This would most certainly have a rather negative effect on payment system stability and is therefore a sanction that is both very drastic and very difficult to use in practise.

[8] It should be added that the Riksbank did act as lender of last resort on a few occasions before the government guarantee was announced. After that the Riksbank formally acted as lender but the government had of course taken over the risk. The "bridge loan" phase, for which we have argued that the modern version of the lender of last resort facility is designed, was not needed, because of the prompt government intervention.

for recapitalisation without consent or claims of priority from the former shareholders. A proposal on how such a supplement to the regulatory framework should be designed is one of the tasks given to the above mentioned Government Committee.[9]

The Bank has set up an action plan based on the experiences of acting as lender of last resort during the ERM crisis in 1992.

To be prepared for its role as lender of last resort, the Bank has set up an action plan. This is based on the experiences of acting as lender of last resort during the ERM crisis in 1992. The plan consists of the logistics of crisis resolution, answers to some legal questions connected with extraordinary lending and a description of the documentation which is necessary should the Riksbank need to act as lender of last resort. The plan also includes an information strategy and some guidelines for crisis analysis.

The plan centres around a crisis staff consisting of key Riksbank personnel as well as representatives of the Financial Supervisory Authority whose task it is to recommend actions to the Executive Board of the Riksbank.

A financial system analysis group will also be set up. A parallel group made up of members of the Bank's trading room will monitor developments in the financial markets. The financial system analysis group is supposed to base its work on the ongoing analysis of bank profitability, case studies of different types of financial disturbances and legal evaluation on the Riksbank's options. The legal and technical analysis will provide guidance to the range of actions which the Riksbank can take, how lender of last resort activities can be carried out so as to minimise moral hazard, and the freedom with which the Riksbank may target its lending in accordance to the legislative framework.

Phase three – crisis management

There is no foolproof system that can completely eliminate the danger of a new bank crisis.

The analysis of financial system stability mentioned earlier attempts to identify unstable situations in the banking sector at an early stage. Building on the lessons from the past, we hope to avoid this kind of problem or limit its scope. Although the Riks-

[9] A reasonable starting point for this work would be an analysis of the system for prompt corrective action (PCA) and structured early intervention and resolution (SEIR) recently codified in the Federal Deposit Insurance Corporation Improvement Act (FDICIA) in the USA. Of course, the legal system, the structure of the banking sector and the way supervision is organised are all very different in Sweden as compared to the USA. The framework to be established must therefore necessarily get a rather different design.

bank has increased its competence and preparedness, there is no foolproof system that can completely eliminate the danger of a new bank crisis. However, by drawing lessons from the crisis management in the early 1990s, the likelihood of a successful management of future crisis can be increased.

The task of the central bank is clearly to provide emergency liquidity, not to get involved with recapitalisation.

These are basic principles that are to be followed in a potential future crisis. The crisis management policy should be characterised by a great degree of openness, in combination with information efforts towards market participants, both regarding the extent of the problems faced and the measures to be taken. This contributes to reducing uncertainties in the market that tend to create even larger problems. The authority in charge of implementing the support policies should be kept separate from the political sphere and from the central bank in order to avoid a conflict of interests. In the Swedish banking crisis, the Ministry of Finance set up the Bank Support Authority to deal exclusively with all matters of unwinding, recapitalisation, etc. of the ailing banks. The task of the central bank is clearly to provide emergency *liquidity*, not to get involved with recapitalisation. Experience also shows that it is problematic for a supervisor to be responsible for the actual management of ailing banks. The authority should have an analytical framework guiding the work of bank reconstruction. It should include a strategy as to the desired future structure of the banking sector. The risk for moral hazard should be minimised: support measures should be constructed so that the credit institutions have the incentive to use them as little as possible. Official support should, whenever possible, take the form of "participation capital" rather than loans – the aim being to benefit financially from the "upside" when the bank once again becomes profitable. Some form of asset management company should be established to handle non-performing and otherwise impaired loans.

Sweden came out of the acute phase of the crisis swiftly and at a relatively low cost.

In summary, considering the extent of the problems in the bank sector in the early 1990s, Sweden came out of the acute phase of the crisis swiftly and at a relatively low cost. This was due to a good portion of luck but also, we believe, successful crisis management. The key elements in the successful management of the crisis of 1992 were the speed with which confidence in the financial system was restored and the efficient division of tasks that involved the creation of the BSA – a separate entity from both the FSA and the central bank. The main impression is that the scheme set up for the BSA was appropriate and that the implementation was

performed in accordance with this scheme. Our conclusion is that future crisis management in phase three could draw heavily on the experiences of the BSA.

Regarding the acute phase of the crisis, the rapid restoration of confidence was achieved through the unlimited government guarantee followed up by distinct information efforts directed towards both domestic and international market players. This demanded a high degree of political consensus, which fortunately could be achieved at that moment. However, although this was a crucial aspect of the successful management of the crisis, there can be no certainty that it will be present in potential future crisis. Clearly, the alternative to this "political consensus" approach in the preservation of confidence is given by the central bank's role as a lender of last resort.

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Notices

Urban Bäckström appointed Governor for six years

The six members of the Riksbank's new Executive Board have been appointed. Urban Bäckström (term six years) is Chairman of the Executive Board and Governor of the Riksbank. Mr Bäckström has been Governor of the Riksbank for the past five years. Lars Heikensten (term five years) is the Governor's alternate, First Vice Chairman and Deputy Governor. Eva Srejber (term four years) is Second Vice Chairman and Deputy Governor. Villy Bergström (term three years) is Deputy Governor. Kerstin Hessius (term two years) is Deputy Governor. Lars Nyberg (term one year) is Deputy Governor.

New Governing Council

Sven Hulterström (s)* is Chairman and Johan Gernandt (m) Vice Chairman of the new Governing Council of the Riksbank. The other members are Sinikka Bohlin, Jörgen Andersson, Britt Bohlin, Kjell Nordström and Susanne Eberstein, all (s), and Kenneth Kvist (v), Mats Odell (kd), as well as Ingegerd Troedsson and Peter Egardt (m).

Riksbank forms cash handling company

The Executive Board of the Riksbank has decided to form a company called PSAB Pengar i Sverige AB (Money in Sweden plc), in accordance with the decision by the Governing Council. The principal activities of the company involve

* Explanation of political affiliations. m: Moderate; kd: Christian Democrat; s: Social Democrat; v: Left.

the maintenance and development of systems for the distribution and handling of cash payment instruments in Sweden.

At the ensuing constituent general meeting, Deputy Governors Lars Nyberg and Kerstin Hessius, together with Kersti Eriksen, Administrative Director, and Hans Krook, Head of the Cashiers' Department, were elected to the Board of the company. At its constituent meeting, the Board then elected Mr. Nyberg to be Chairman of the Board and Mr. Krook to be Managing Director of the company.

Support for inflation target continues to grow

Sixty-eight per cent of Swedish adults are in favour of the 2 per cent inflation target, compared to 63 per cent a year ago. The proportion who approve of how the Riksbank conducts monetary policy has risen to 57 per cent, compared to 53 per cent a year ago.

These figures come from a survey of public knowledge and attitudes carried out for the Riksbank.

Irrevocable exchange rates for conversions to the euro

On 31 December 1998, the Council of the European Union fixed the conversion rates between the euro and the currencies of the member states that have adopted the euro. These conversion rates are in effect from 1 January 1999.

Here is the value of 1 euro in the various currencies:

40.3399 Belgian francs
1.95583 German marks
166.386 Spanish pesetas
6.55957 French francs
0.787564 Irish pounds
1936.27 Italian lire
40.3399 Luxembourg francs
2.20371 Dutch guilders
13.7603 Austrian shillings
200.482 Portuguese escudos
5.94573 Finnish marks

Monetary policy calendar

1997.01.02 The *reference* (official discount) *rate* is confirmed by the Riksbank Governor at 2.5 per cent as of 3 January 1997.

1997.04.01 The *reference* (official discount) *rate* is confirmed by the Riksbank Governor at 2.5 per cent (unchanged).

1997.07.01 The *reference* (official discount) *rate* is confirmed by the Riksbank Governor at 2.5 per cent (unchanged).

1997.10.01 The *reference* (official discount) *rate* is confirmed by the Riksbank Governor at 2.5 per cent (unchanged).

1997.12.11 The *fixed repo rate* is increased by the Riksbank Governor from 4.10 to 4.35 per cent as of 17 December 1997. Due to the Christmas and New Year holidays, the repo rate set on 16 December will apply for four weeks until 14 January 1998.

1998.01.02 The *reference* (official discount) *rate* is confirmed by the Riksbank Governor at 2.5 per cent (unchanged).

1998.04.01 The *reference* (official discount) *rate* is confirmed by the Riksbank Governor at 2.5 per cent (unchanged).

1998.06.04 The *fixed repo rate* is lowered by the Riksbank Governor from 4.35 per cent to 4.10 per cent as of 9 June 1998.

1998.07.01 The *reference* (official discount) *rate* is confirmed by the Riksbank Governor at 2.0 per cent as of 2 July 1998.

1998-11-03 The *fixed repo rate* is lowered by the Riksbank Governor from 4.10 per cent to 3.85 per cent as of 4 November 1998.

1998-11-12 The Riksbank lowers its *deposit and lending rates*, in each case by 0.5 percentage points, as of 18 November 1998, thereby setting the deposit rate at 3.25 per cent and the lending rate at 4.75 per cent.

1998-11-24 The *fixed repo rate* is lowered by the Riksbank Governor from 3.85 per cent to 3.60 per cent as of 25 November 1998.

1998-12-15 The *fixed repo rate* is lowered by the Riksbank Governor from 3.60 per cent to 3.40 per cent as of 16 December 1998.

1999-01-04 The *reference* (official discount) *rate* is confirmed by the Riksbank Governor at 1.5 per cent as of 5 January 1999.

1999-01-05 The *fixed repo rate* is confirmed by the Riksbank Governor at 3.40 per cent. The decision is extended on 29 January 1999 to apply until 17 February 1999.

1999-02-12 The *fixed repo rate* is lowered by the Riksbank Governor to 3.15 per cent as of 17 February 1999.

1999-02-12 The Riksbank lowers its *deposit and lending rates*, in each case by 0.5 percentage points. The deposit rate is set at 2.75 per cent and the lending rate at 4.25 per cent. The decision takes effect on 17 February 1999.

1999-03-25 The *fixed repo rate* is lowered by the Riksbank Governor to 2.80 per cent as of 31 March 1999.

Statistical appendix

Statistics from Sveriges Riksbank are to be found on the Internet (http://www.riksbank.se). Dates of publication of statistics regarding the Riksbank's assets and liabilities including foreign exchange reserves plus financial market and the balance of payments statistics are available on the homepage of the International Monetary Fund, IMF (http://dsbb.imf.org). Dates of publication can also be obtained from the Information Centre at Sveriges Riksbank.

Daily capital market interest rates (Table 13), daily overnight and money market interest rates (Table 14) and daily krona exchange rates (Table 16) can be ordered from the Information Centre at Sveriges Riksbank via e-mail: info@riksbank.se, fax: +46 8 787 05 26 or phone: +46 8 787 01 00.

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1 Riksbank's assets and liabilities

Assets. Period-end stock figures. SEK million

		Foreign exchange[1]	Government securities	Lending to banks	Fixed assets	Other	**Total**
1997	Juli	102 787	56 152	43	1 203	17 374	177 559
	Aug	101 005	56 172	1 156	1 205	18 467	178 005
	Sept	109 393	56 203	1 375	1 210	13 358	181 539
	Okt	116 233	56 677	2 349	1 218	9 805	186 282
	Nov	103 904	57 007	1 048	1 224	27 495	190 678
	Dec	90 228	53 811	4 118	1 242	37 347	186 746
1998	Jan	92 654	54 081	3 464	1 245	35 780	187 224
	Feb	78 329	53 672	192	1 182	54 429	190 265
	Mars	82 954	43 335	9	1 186	58 587	188 532
	April	103 679	35 651	102	1 193	50 208	193 294
	Maj	107 781	36 828	1 504	1 199	41 432	191 205
	Juni	106 248	35 808	4	1 207	45 601	191 205
	Juli	110 112	36 052	1 014	1 215	39 078	190 274
	Aug	115 613	37 526	71	1 222	32 992	189 885
	Sept	130 597	34 885	19	1 230	21 222	190 414
	Okt	127 619	35 118	756	1 237	26 450	193 641
	Nov	124 234	34 784	4 664	1 248	28 015	195 406
	Dec	113 464	35 576	2 265	1 151	43 594	198 614
1999	Jan	113 875	36 086	1	1 162	44 617	195 757

Liabilities

		Notes and coins in circulation	Riksbank liquidity bills	Bank deposits in the Riksbank	Capital liabilities	Other	**Total**
1997	Juli	73 583	–	1 016	32 239	70 721	177 559
	Aug	75 182	–	59	32 239	70 525	178 005
	Sept	74 320	–	955	32 239	74 025	181 539
	Okt	74 783	–	2 849	32 239	76 411	186 282
	Nov	75 889	–	76	32 239	82 474	190 678
	Dec	82 795	–	1 967	32 239	69 745	186 746
1998	Jan	77 559	–	114	32 239	77 312	187 224
	Feb	76 621	–	925	32 211	66 257	190 265
	Mars	76 680	–	392	32 211	65 998	188 532
	April	76 417	–	220	32 211	70 195	193 294
	Maj	77 096	–	1 460	37 162	75 487	191 205
	Juni	77 669	–	951	37 162	75 547	191 205
	Juli	78 002	–	66	37 162	75 044	190 274
	Aug	79 203	–	1 665	37 162	73 175	189 885
	Sept	78 275	–	3 377	37 162	71 600	190 414
	Okt	78 991	–	120	37 162	77 368	193 641
	Nov	79 633	–	50	37 162	78 561	195 406
	Dec	86 268	–	1 679	37 162	73 505	198 614
1999	Jan	81 539	–	653	37 162	76 403	195 74

2 Money supply

End-of-month stock

	SEK million			Twelve months change in per cent	
	M0	M3		M0	M3
1997					
Jan	67 503	791 513	Jan	5.3	7.4
Feb	67 490	783 635	Feb	5.8	7.4
March	68 683	807 482	March	7.4	6.5
April	67 473	788 247	April	5.4	4.3
May	67 527	794 077	May	5.1	4.1
June	68 101	807 112	June	4.7	5.3
July	66 763	791 753	July	5.0	3.2
Aug	68 623	804 033	Aug	4.0	4.6
Sept	68 118	799 854	Sept	3.7	2.1
Oct	68 556	799 604	Oct	5.7	3.4
Nov	69 762	807 415	Nov	4.6	1.3
Dec	74 380	826 242	Dec	3.0	1.3
1998					
Jan	70 751	821 712	Jan	4.8	3.8
Feb	70 434	806 800	Feb	4.4	3.0
March	69 560	802 877	March	1.3	–0.6
April	70 181	807 368	April	4.0	2.4
May	70 783	814 796	Mayl	4.8	2.6
June	71 118	829 968	June	4.4	2.8
July	71 369	835 079	July	6.9	5.5
Aug	73 042	835 199	Aug	6.4	3.9
Sept	71 954	838 568	Sept	5.6	4.8
Oct	73 041	846 579	Oct	6.5	5.9
Nov	73 929	852 805	Nov	6.0	5.6
Dec	78 139	843 416	Dec	5.1	2.1

3 Interest rates set by the Riksbank

Per cent

	Date	Repo rate	Deposit rate	Lending rate		Date	Discount rate
1996	08-14	5.40			1994	01-04	4.50
	08-21		4.75	6.25		07-04	5.50
	08-28	5.25				10-04	7.00
	09-11	5.15			1995	07-04	7.50
	09-25	5.05				10-06	7.00
	10-09	4.95			1996	01-03	6.00
	10-23	4.80				04-02	5.50
	10-30	4.60	4.25	5.75		07-02	4.50
	11-27	4.30				10-02	3.50
	12-11		3.75	5.25	1997	01-03	2.50
	12-18	4.10			1998	07-02	2.00
1997	12-17	4.35			1999	01-05	1.50
1998	06-10	4.10				04-06	1.00
	11-04	3.85					
	11-18		3.25	4.75			
	11-25	3.60					
	12-16	3.40					
1999	02-17	3.15	2.75	4.25			
	03-31	2.90					

4 Capital market interest rates

Effective annualized rate for asked prices. Monthly average, per cent

		Bonds issued by:					
		Central government				Housing (Caisse)	
		3 years	5 years	7 years	9–10 years	2 years	5 years
1997	Jan	4.96	5.39	5.97	6.74	4.37	5.88
	Feb	4.98	5.61	5.96	6.68	4.57	6.00
	March	5.42	6.17	6.38	7.10	5.26	6.66
	April	5.47	6.27	6.51	7.24	5.28	6.78
	May	5.38	6.09	6.33	6.99	5.20	6.62
	June	5.27	5.92	6.15	6.80	5.09	6.41
	July	5.13	5.64	5.86	6.44	5.04	6.09
	Aug	5.33	5.82	6.00	6.53	5.24	6.27
	Sept	5.26	5.70	5.86	6.38	5.15	6.13
	Oct	5.42	5.76	5.86	6.22	5.36	6.19
	Nov	5.57	5.88	5.98	6.30	5.56	6.42
	Dec	5.46	5.71	5.77	6.03	5.55	6.29
1998	Jan	5.15	5.33	5.49	5.65	5.56	5.81
	Feb	5.02	5.19	5.36	5.53	5.37	5.63
	March	4.95	5.06	5.18	5.35	5.27	5.44
	April	4.88	4.99	5.05	5.21	5.16	5.31
	May	4.83	4.98	5.04	5.20	5.08	5.25
	June	4.46	4.70	4.79	4.97	4.70	4.96
	July	4.36	4.61	4.71	4.88	4.58	4.88
	Aug	4.39	4.60	4.66	4.80	4.68	4.99
	Sept	4.37	4.56	4.63	4.79	4.72	5.15
	Oct	4.35	4.53	4.68	4.75	4.71	5.30
	Nov	3.94	4.19	4.47	4.59	4.18	4.79
	Dec	3.64	3.86	4.12	4.25	3.89	4.46
1999	Jan	3.71	3.59	3.87	4.02	3.59	4.14

5 Overnight and money market interest rates

Monthly average, per cent

		Repo rate	Inter-bank rate	SSVX			Company certificates	
				3 months	6 months	12 months	3 months	6 months
1997	Jan	4.10	4.20	3.76	3.81	3.90	3.95	4.00
	Feb	4.10	4.20	3.93	4.00	4.11	4.13	4.20
	March	4.10	4.20	4.13	4.23	4.42	4.34	4.43
	April	4.10	4.20	4.03	4.15	4.52	4.24	4.35
	May	4.10	4.20	4.09	4.20	4.57	4.30	4.40
	June	4.10	4.20	4.05	4.15	4.44	4.28	4.37
	July	4.10	4.20	4.06	4.21	4.40	4.36	4.46
	Aug	4.10	4.20	4.17	4.33	4.40	4.45	4.60
	Sept	4.10	4.20	4.11	4.25	4.63	4.37	4.53
	Oct	4.10	4.20	4.23	4.41	4.78	4.49	4.68
	Nov	4.10	4.20	4.31	4.51	5.13	4.59	4.79
	Dec	4.19	4.29	4.42	4.70	5.06	4.70	4.99
1998	Jan	4.35	4.45	4.41	4.55	4.82	4.67	4.59
	Feb	4.35	4.45	4.33	4.51	4.71	4.56	4.73
	March	4.35	4.45	4.48	4.56	4.72	4.68	4.76
	April	4.35	4.45	4.47	4.58		4.66	4.76
	May	4.35	4.45	4.49	4.51		4.67	4.23
	June	4.18	4.28	4.20	4.20	4.26	4.39	4.38
	July	4.10	4.20	4.11	4.11		4.29	4.30
	Aug	4.10	4.20	4.19	4.23		4.37	4.39
	Sept	4.10	4.20	4.19	4.18	4.26	4.36	4.36
	Oct	4.10	4.20	4.20	4.18		4.36	4.34
	Nov	3.83	3.93	3.82	3.75		4.00	3.96
	Dec	3.51	3.61	3.45	3.51	3.53	3.65	3.69
1999	Jan	3.40	3.50	3.27	3.25		3.45	3.46

6 Treasury bills and selected international rates

Annualized rate. Monthly average, per cent

		3-month deposits					6-month deposits				
		USD	DEM	EUR	GBP	SSVX	USD	DEM	EUR	GBP	SSVX
1997	Jan	5.58	3.13		6.47	3.76	5.67	3.14		6.66	3.81
	Feb	5.50	3.19		6.35	3.93	5.60	3.19		6.49	4.00
	March	5.62	3.29		6.42	4.13	5.79	3.30		6.54	4.23
	April	5.81	3.25		6.48	4.03	5.99	3.29		6.74	4.15
	May	5.80	3.20		6.54	4.09	5.97	3.26		6.72	4.20
	June	5.77	3.16		6.77	4.05	5.89	3.22		6.91	4.15
	July	5.72	3.16		7.05	4.06	5.81	3.23		7.24	4.21
	Aug	5.69	3.28		7.25	4.17	5.82	3.42		7.37	4.33
	Sept	5.67	3.34		7.29	4.11	5.80	3.48		7.43	4.25
	Oct	5.73	3.65		7.36	4.23	5.80	3.78		7.46	4.41
	Nov	5.83	3.78		7.71	4.31	5.87	3.89		7.77	4.51
	Dec	5.89	3.76		7.69	4.42	5.94	3.84		7.77	4.70
1998	Jan	5.62	3.57		7.57	4.41	5.67	3.67		7.57	4.55
	Feb	5.61	3.53		7.53	4.33	5.63	3.62		7.52	4.50
	March	5.63	3.54		7.53	4.48	5.67	3.72		7.55	4.56
	April	5.66	3.63		7.47	4.47	5.71	3.73		7.46	4.58
	May	5.66	3.61		7.47	4.49	5.73	3.72		7.45	4.51
	June	5.67	3.56		7.70	4.20	5.72	3.66		7.74	4.20
	July	5.64	3.55		7.77	4.11	5.72	3.63		7.83	4.11
	Aug	5.63	3.51		7.70	4.19	5.68	3.59		7.69	4.23
	Sept	5.47	3.50		7.45	4.19	5.39	3.56		7.33	4.18
	Oct	5.18	3.48		7.05	4.20	4.97	3.45		6.83	4.18
	Nov	5.24	3.56		6.79	3.82	5.06	3.51		6.55	3.75
	Dec	5.14	3.26		6.27	3.45	5.00	3.22		5.97	3.51
1999	Jan	4.88		3.04	5.74	3.27	4.89		2.99	5.52	3.25

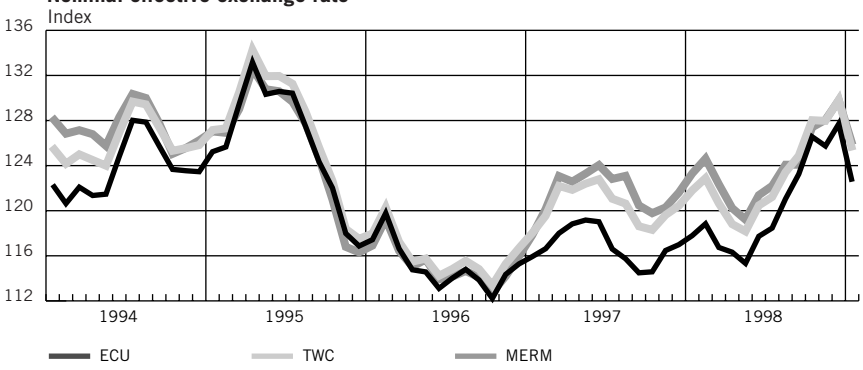
7 Krona exchange rate: theoretical ECU index, TCW-weighted index and MERM-weighted index; selected exchange rates

Annual and monthly averages; annual highs and lows

					SEK per			USD per	
		ECU-index	TCW-index	MERM-index	USD	100 DEM	100 JPY	DEM	JPY
1997	Jan	115.93	118.02	117.84	7.06	440.02	5.99	1.60	117.83
	Feb	116.63	119.55	120.15	7.40	442.22	6.02	1.67	122.93
	March	119.00	122.20	123.07	7.65	450.95	6.25	1.70	122.57
	April	118.83	121.85	122.56	7.68	449.31	6.12	1.71	125.56
	May	119.17	122.40	123.29	7.67	450.73	6.46	1.70	118.61
	June	119.02	122.79	124.05	7.74	448.77	6.78	1.73	114.29
	July	116.60	121.06	122.82	7.81	436.41	6.78	1.79	115.24
	Aug	115.74	120.63	123.09	8.00	433.89	6.78	1.84	117.88
	Sept	114.49	118.62	120.47	7.70	430.56	6.38	1.79	120.73
	Oct	114.58	118.36	119.78	7.57	430.99	6.26	1.76	120.96
	Nov	116.47	119.62	120.29	7.56	436.58	6.04	1.73	125.18
	Dec	116.99	120.44	121.51	7.78	438.03	6.01	1.78	129.49
1998	Jan	117.79	121.66	123.30	8.01	441.26	6.20	1.82	129.50
	Feb	118.84	122.89	124.62	8.08	445.30	6.43	1.81	125.69
	March	116.74	120.65	122.35	7.97	436.38	6.18	1.83	129.00
	April	115.32	118.81	120.23	7.82	431.37	5.93	1.81	132.13
	May	115.33	118.17	119.21	7.69	433.42	5.70	1.77	134.96
	June	117.73	120.47	121.38	7.91	441.36	5.62	1.79	140.15
	July	118.46	121.22	122.20	7.98	444.30	5.68	1.80	140.63
	Aug	121.04	123.41	124.08	8.13	447.30	5.48	1.79	144.68
	Sept	123.25	124.88	124.68	7.91	464.26	5.88	1.70	134.57
	Oct	126.56	128.03	127.40	7.85	479.02	6.49	1.64	120.78
	Nov	125.74	127.97	128.06	7.99	475.49	6.64	1.68	120.35
	Dec	127.70	129.83	129.79	8.05	482.79	6.86	1.67	117.24
1999	Jan	122.57	125.46	125.95	7.82	464.45	6.92	1.69	113.16

Note. The base for the ECU index is the central rate with the ecu on 17 May 1999; for the Merm-weighted and the TCW index it is 18 November 1992.

8 Nominal effective exchange rate



Note. The base for the ECU index is the central rate with the ecu on 17 May 1991; for the MERM-weighted and TCW index it is 18 November 1992.

9 Forward foreign exchange market

Forward net position with authorized currency dealers. SEK million, period ends

		Non-bank public		Bank abroad	Riksbank	Total
		Resident (1)	Non-resident (2)	Net (3)	Net (4)	(1+2+3+4)
1997	Nov	–196 129	–20 816	130 549	–1 308	– 87 704
	Dec	–204 680	–20 564	99 998	155	–125 091
1988	Jan	–212 998	–22 001	140 364	– 262	– 94 897
	Feb	–186 583	–18 304	119 476	1 382	– 84 029
	March	–192 115	–19 175	142 227	5	– 69 058
	April	–186 239	–17 669	122 320	397	– 81 191
	May	–174 575	–47 495	133 608	0	– 88 462
	June	–220 387	–23 274	112 675	0	–130 986
	July	–218 997	–22 052	129 587	0	–111 462
	Aug	–284 131	–27 586	201 845	0	–109 872
	Sept	–239 370	–26 312	178 740	0	– 86 942
	Oct	–283 253	–29 446	157 158	0	–155 541

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