

■ The use of market indicators in financial stability analysis

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In the financial stability analysis the Riksbank monitors the credit risk developments of the main borrowers in the Swedish banking system in order to assess the stability of the financial system. Indicators of credit risk and financial health are continuously evaluated and further developed within the Riksbank. In this paper we present some new indicators based on equity and bond markets that the Riksbank employ in its assessment. Furthermore, we also present some evidence of the usefulness of the indicators by looking at the Swedish banking crisis and analyse how the indicators reacted and behaved during the stressful period of time.

Introduction

Sveriges Riksbank is a non-supervisory central bank with an overall objective to promote a safe and efficient payment system. One of the major threats to payment system stability is bank failures. The Riksbank therefore monitors the stability of the banking system on an ongoing basis and presents its assessment of stability in the semi-annual Financial Stability Report which has two major parts.

The first part of the Financial Stability Report covers macroeconomic developments, in particular how the soundness of the banks' major borrowers – the household and corporate sectors – is developing. The indicators have mainly been either of a macro- or microeconomic nature. Market indicators can be used to analyse the corporate sector, but also to some extent the real estate sector – a sub-sector on which the Riksbank focuses specifically, because of its importance for banking system soundness.

The second part concerns analysing the soundness of the banking sector, mainly from an analysis of balance sheets and income statements. More recently, the Riksbank has started to make use of information from market prices to complement its regular analysis. Market information from prices on securities issued by banks can provide direct information on how market participants assess the risk in the banks.

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This paper discusses the general view that the Riksbank has taken on the use of market information and on the indicators the bank has chosen to develop and use in its stability analysis.

General features of market indicators

Market indicators have many attractive features, which distinguish them from other types of indicators, e.g. accounting-based indicators. Three such features are:

- Market indicators are forward-looking, while most other types of indicators, such as those based on national accounts or financial statements, are retrospective.
- They are frequently and immediately available; reliable prices can be updated daily and there is no time lag between the time they are generated and the time they are made public.
- Various methods exist for extracting information and calculating risk measures from market prices.

In the coming sections, we will present the methods and measures the Riksbank has chosen to use in its analysis and examine the reasons for doing so.

The usefulness of market indicators relates to markets' abilities to assess risk correctly and to whether this adds something to the regular analysis.

The main question concerning the usefulness of market indicators relates to markets' abilities to assess risk correctly and to whether this adds something to the regular analysis. Market prices incorporate the aggregate valuation of all publicly available information. This means that they provide a picture of the average view of a large number of market participants who invest a lot of effort in understanding what the accurate value of a particular security should be. It is not self-evident that central bankers or supervisors are better informed of the soundness of an institution than the investors' that invest in the institutions securities. Central bankers and supervisors need an information advantage to compensate for the collective knowledge of the well-informed traders of the securities markets.

Central bankers' and supervisors' information advantage comes from the fact that authorities are able to obtain proprietary information on any relevant institution through regulatory reporting or other supervisory measures. For the Riksbank, which mainly focuses on the four largest Swedish banks, this information advantage is not substantial. All four banks are traded on the stock exchange, where the requirements on financial statements are high, both in terms of frequency (quarterly) and

content. The information available from supervisory reporting or the monthly balance sheet statistics reported to the Riksbank does not add that much to the public reporting. Hence, the main advantage exists when there are events and possibilities to request special information from the institutions, for example when a particular industry experiences severe problems and information on exposures to that industry can be collected.

On the other hand, there are a number of reasons why markets may not always assess the available information correctly, at least with respect to the needs of the authorities, that is to obtain a picture of the risk in the relevant institutions.

Firstly, market prices may reflect other aspects than a valuation of an institution's ability to yield returns to investors. The most apparent aspect of this is liquidity. For many securities, variations in prices reflect variations in supply and demand factors, rather than changes in valuation of the prospects of future returns. Liquidity aspects may thus put a limit on which market indicators can be used for practical analytical purposes.

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Another reason why market information may become less useful is that the focus of investors may be different from that of the authorities, in particular when it comes to risk. The authorities are mainly interested in the risk of bank failures, which is normally a highly unlikely event. Investors may not have incentives to address this risk as strongly. There are arguments that this may be a problem both for debt instruments and equities, although for different reasons. For equities, limited liability for shareholders may lead to an upside focus by equity investors and little regard for potential losses. When it comes to debt instruments, particularly those issued by very large banks, there is always a likelihood of public support to debt holders should the bank run into problems. This holds true in particular for short-term debt, since investors think that they will receive support at least if a problem arises very suddenly. This is one of the main reasons why subordinated debt, which has low seniority in case of failure, has been discussed as the theoretically most attractive security to use for market indicators of bank risk. However, the problem with lack of risk focus should not be exaggerated. Even if investors may not have a reason to focus on extreme events such as sudden failures, they would be hurt by deterioration in earnings or substantial losses, and information of an increased likelihood of these events should prompt movements in market prices.

Market information may become less useful because the focus of investors may be different from that of the authorities, in particular when it comes to risk.

An additional, but related, reason why market information may have shortcomings in signalling risk is that banks are opaque. This opaqueness limits market participants' knowledge of a bank's risk profile. The Riksbank has frequent discussions in particular with analysts and end-investors in Swedish bank equity. These discussions show that investors have lit-

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tle more than aggregated measures of the credit portfolio, some retrospective measures of credit losses and some idea of the quality of credit management, as a means to assess the risk for credit losses in a particular bank. Thus, it is quite hard for market participants to successfully assess a bank's risks. On the other hand, investors tend to be quite quick at picking up even vague rumours of any deterioration in a bank's expected earnings. Fortunately, most of the recent academic research provides some reassurance concerning the reliability of bank equity market information. These findings suggest that banks are not harder for equity investors to value than non-financial firms (see for example Flannery et al. 2002).

A final reason why there may be problems with risk assessments from market information is the issue of market overreactions or herding.

A final, related reason why there may be problems with risk assessments from market information is the issue of market overreactions or herding. Markets are normally sensitive to bad news, and market prices tend to move strongly on these occasions.¹ When information that shows a large shift in risk for a bank reaches the market, it is questionable whether market prices really represent a fair valuation of the bank's risk. Moreover, the information often reaches the authorities at the same time, and they may be better situated to actually evaluate the importance of the particular information, by demanding qualifications from the bank itself.

To improve our understanding of the behaviour of market-based indicators it is of paramount importance that the indicators are studied during stressful periods of time.

In the empirical analysis concerning the use of market-based indicators, as with many early-warning models, we face an econometrical problem.² Market information seems to produce low type-I errors, that is, misclassifying problem banks as non-problem banks. However, the type-II error is probably larger, that is, they give warnings on occasions where there are no problems. To improve our understanding of the behaviour of market-based indicators it is thus of paramount importance that the indicators are studied during stressful periods of time and, if possible, also to use or analyse different market-based indicators.

Firstly, obtaining empirical results is key. Secondly, market indicators should be used as a complement to the regular analysis.

To sum up, for the Riksbank's purposes, market information has many attractive features as forward-looking, high-frequency, readily-available and information-intensive indicators. The caveats mean, however, that they need to be handled with caution. This leads to two important conclusions for the Riksbank. Firstly, obtaining empirical results is key. It is difficult to find out by any other means whether market information produces good indicators. As will be discussed in the following, empirical results seem to present quite strong evidence for some types of indicators,

¹ For a discussion on the mechanisms behind herd behaviour, see Sveriges Riksbank (2002).

² Early-warning models combine a set of bank-level financial indicators (balance sheet, income statement and market indicators), as well as other variables, often on the macroeconomic conditions, to make a prediction about the state of a bank. See Gilbert et al. (1999).

and this has been very important for the Riksbank's decision to make use of market indicators. Secondly, market indicators should be used as a complement to the regular analysis. They provide a benchmark for the regular internal analysis and a good starting point for evaluating it.

The rest of this paper discusses which indicators the Riksbank has chosen to develop and use. Generally, the Riksbank has focused strongly on equity-based rather than debt-based indicators. We therefore discuss our stances on these two general types of indicators separately.

In general, we base our reasoning on what indicators to use by looking at previous research and then focussing particularly on the Swedish circumstances that are relevant for evaluating whether or not a particular indicator would be useful for us. In particular, we evaluate the significance of any indicator on data from the Swedish banking crisis in the early 1990s. This is informative, since it is a real test of the markets' abilities to signal risk in a case where several banks actually became insolvent and also of the markets' abilities to distinguish the ones that actually failed from those who managed to survive. Since the Swedish banking crisis, debt and equity markets have undergone significant development, that is, new instruments and actors, higher trading volumes and a higher degree of internationalisation. If data from the Swedish banking crisis supports the use of market-based indicators for signalling bank fragility then, due to the developments of the Swedish and international financial markets, more recent data should be even more useful for signalling bank distress. In order to give the reader a reference to the timing of market reactions, the timeline of the crisis is described in the box below.³

We present indicators for six banks over the period of the crisis. During the period 1987 to 1994 there were eleven banks listed on the Swedish stock exchange. However, only six banks lived through the entire period. Therefore, we present the indicators, when data is available, for a total of six banks. Three of the banks can be classified as having been in a fragile situation during the banking crisis, namely, Gota Bank, Nordbanken and Skandinaviska enskilda banken, SEB. The other surviving banks are Östgöta Enskilda Bank, JP Bank and Svenska Handelsbanken, SHB. In addition, indicators for the four large banks in Sweden during 1997–2003: SEB, SHB, Nordea, NDA, (formerly Nordbanken) and FöreningsSparbanken, FSPA, (formerly Sparbanken Sverige) are presented.

We present indicators for the six banks that lived through the entire period of the crisis, that is 1987 to 1994.

³ For a more detailed description of the crisis, see Dress & Pazarbasioglu (1998) or Andersson & Viotti (1999).

The Swedish banking crisis

1990	The first problems in the financial system became apparent when the sector of finance companies suffered severe losses, and some companies suspended their payments. The finance companies were non-bank credit institutions, which to a large part funded loans to the real estate sector by issuing short-term commercial papers but also through bank funding. A substantial part of these companies reduced their businesses significantly or were liquidated. No government support was granted.
Autumn 1991	Nordbanken (the 3 rd largest bank at the time, owned to 75 per cent by the state) had incurred large credit losses. It needed a capital infusion of SEK 5 billion ⁴ to meet its capital adequacy ratio, which was provided predominantly by the state on 10 October.
Autumn 1991	Första Sparbanken (one of the major banks in the savings banks sphere) had also incurred severe losses, and turned to the government for aid. It received a guarantee of SEK 3.8 billion. This guarantee was used and turned into a loan in March 1992.
Spring 1992	The government took full control over Nordbanken on 8 May.
September 1992	It became apparent that Gota Bank, the 6 th largest bank, was insolvent. The major shareholder Gota AB refused to provide more capital. On 9 September, the government made a commitment to enable Gota Bank to honour their financial obligations. Later that autumn, the state took over the shares in Gota Bank. Gota AB suspended payments on 16 September.
September 1992	The currency crisis took place. The Riksbank intervened to defend the fixed exchange rate. After interventions in early September the crisis peaked on 16 September, when the marginal lending rate was raised first from 20 per cent to 75 per cent, and later the same day to 500 per cent.
September 1992	The general banking guarantee was presented by the government on 24 September. The state guaranteed all liabilities, but not equity, in Swedish banks.
Autumn 1992	The capital injections one year earlier to strengthen Nordbanken had not been sufficient, and the bank was reconstructed.
November 1992	The Riksbank left the fixed exchange rate regime on 19 November and the krona was allowed to float.
December 1992	SEB, the largest Swedish bank at the time, notified the government that it would probably need government assistance. An application was made on 17 February 1993, but the owners withdrew it later, after they managed to obtain a capital injection.

⁴ 1 EUR = 9 SEK and 1 USD = 8 SEK.

1993

Bank problems were revealed to a further extent and support was given to several banks: Nordbanken, Foreningsbanken and Sparbanken Sverige, the result of a merger in 1992 of the larger savings banks. This meant that four large Swedish banks (rank 3 to 6) received support. The two largest, SEB and Handelsbanken, however, benefited from the general banking guarantee.

Market indicators of bank risk

MARKET INDICATORS BASED ON DEBT INSTRUMENTS

The most commonly used measure of risk where bond markets are concerned is the bond spread. The bond spread is defined as the difference in yield on an x-year bank's bond and a risk-free government bond of similar duration or maturity. Bondholders care more about the downside risk, since bondholders do not gain from increased risk-taking but face an increased likelihood of losses when the risks increase. In particular, spreads from subordinated bonds have a number of attractive features as an indicator. Holders of subordinated debt have more to lose in case of failure due to the low level of seniority and, hence, a greater incentive to monitor the issuer's risk. Bond spreads, and particular spreads on subordinated debts, should increase with increased asset risk and leverage and declining profitability. However, if the authorities are expected to support a failed bank this would probably result in downward bias on, both the size of and change in, the bond spread over time.

Academic research on how well bond prices reflect banks' risk has mainly looked at the relationship between the bond spread and other measures of default risk. In many cases, results based on US data before the early 1990s showed a weak to nonexistent relationship.⁵ One explanation that has been put forward for the weak relationship is that investors during that time believed that bank regulators were implicitly following a too-big-to-fail policy.⁶ They also found some evidence that pricing behaviour changed at the end of the 1980s and that investors were able to differentiate between individual banking firms' credit risk. A recent study by Evanoff & Wall (2001) found that subordinated debt spreads were better than reported capital ratios at predicting banking problems. In a European context, Sironi (2000) analysed the information content of subordinated debt spreads for European banks. The results showed that holders of subordinated debt rationally discriminated between the risk profiles of private banks, and that the risk sensitivity of

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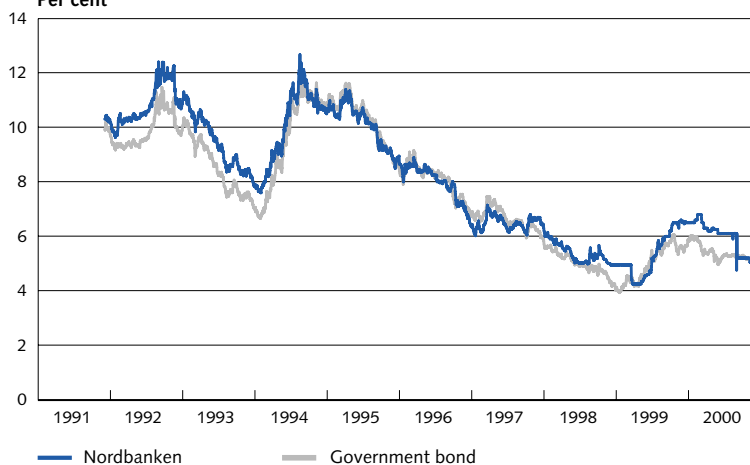
To use the subordinated debt spread as an indicator of the health or risk of Swedish banks, it is important that the bonds are traded in a relatively liquid market.

⁵ See Flannery (1998) for a survey.

⁶ See Flannery & Sorescu (1996).

spreads increased during the 1990s. Gropp, Vesala & Vulpes (2002) found that the bond spreads of European banks signalled problems up to six months before a bank went into financial distress. In the study, financial distress was proxied by Fitch/IBCA financial strength ratings downgraded to C or below. All major banks in Sweden issue subordinated debt and most issues are placed in Sweden or in the Eurobond market. However, not all issues are listed on an exchange, and in order to use the subordinated debt spread as an indicator of the health or risk of Swedish banks, it is important that the bonds are traded in a relatively liquid market. If only quotes are available or the market is illiquid, then the spread will also incorporate a liquidity premium.⁷ Figure 1 displays the ask yield for a subordinated debt issued by Nordbanken, and traded on SOX, a part of the Stockholm stock exchange, as well as a government bond with a similar maturity for the period 1991–2001. The correlation between the two bonds is quite high and the spreads seems to vary over time (see Figure 1). The continuous data series and high volatility of the yields give the impression of actively traded securities. However, a closer scrutiny of the data reveals that the actual number of trades is very low; the average number of daily trades for the subordinated debt issued by Nordbanken during the period August 1999 to December 2001 is less than one.⁸ Thus, the market for subordinated debt in Sweden cannot be characterised as

Figure 1. Yields for bank subordinated debts and a government bond 1991–2000
Per cent



Note: Closing daily ask yield for subordinated debts issued by Nordbanken and a government bond, both with a maturity of ten years.

Sources: SIX Trust and the Riksbank.

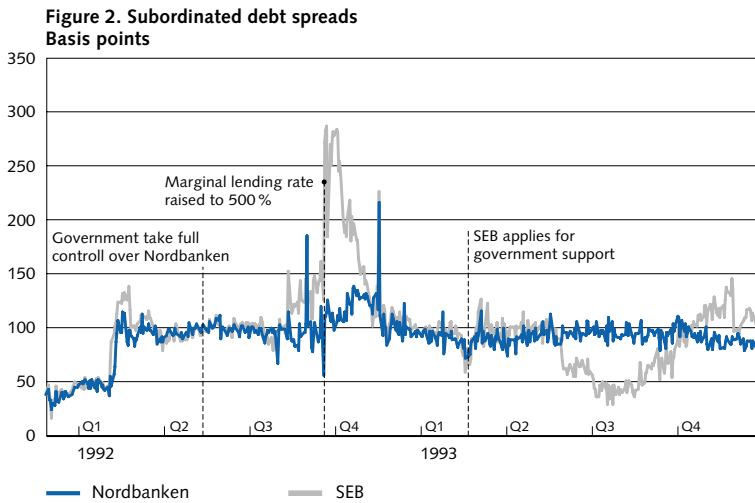
⁷ The liquidity premium is probably correlated with the credit risk component of the spread, but this unclear spread will complicate the analysis of how much information is present in the spread concerning bank risk.

⁸ Statistics are available only from 1999 onwards.

liquid. A consequence of bad liquidity is that movements in spreads may be the result of changes in liquidity rather than credit risk. Hence, the information contained in spreads is probably indistinct.

Figure 2 displays the spread between the yields on the subordinated debts issued by Nordbanken and SEB for the period 29 November 1991 to 30 December 1993, which is during the Swedish banking crisis. The spreads of the subordinated debts are highly correlated over the period and the average spread over the period is similar between the banks (see Figure 2). The average spread for SEB over the period is 97 basis points, and for Nordbanken 91 basis points.⁹ As mentioned above, both Nordbanken and SEB can be classified as being in fragile situations during the banking crisis; nevertheless the difference in average spread between the two banks over the period is very small. In fact, it seems like the spreads are driven more by the general interest level and macroeconomic factors than credit risk (see Figure 2). The largest fluctuations in the spreads take place during the currency crisis in September 1992. It is interesting to note that the spread for SEB increases much more than for Nordbanken during the currency crisis. This may reflect the fact that Nordbanken was under government control and/or that the market considered the credit portfolio of SEB to have a higher exchange rate exposure. The liquidity is, as mentioned above, poor. Actual trading occurs on average in about 50 per cent of the trading days. Hence, it is not surpris-

At present, the debts issued by Swedish banks do not seem liquid enough to be of use in the stability analysis, that may however, change in the future.



Note: Daily spreads between subordinated debts issued by SEB and Nordbanken and a government bond of similar maturity.

Sources: SIX Trust and the Riksbank.

⁹ The average spread for a subordinated debt issued by Föreningsbankernas Bank, with the same maturity and issued during the same period as the bonds in Figure 2, was during the period in Figure 2 equal to 103 basis points.

ing that the spreads do not seem to exhibit any difference between the banks. The Riksbank is, however, like everybody else attracted by the prospects of using subordinated debt spread as market indicators. But at present, the debts issued by Swedish banks do not seem liquid enough to be of use in the stability analysis. This may change in the future, however.

EQUITY-BASED MARKET INDICATORS

The equity market in Sweden is in general a liquid marketplace, and the four largest banks belong to the group of stocks with the highest daily turnover on the Stockholm stock exchange.

The equity market in Sweden is in general a liquid marketplace, and the four largest banks are traded frequently and belong to the group of stocks with the highest daily turnover on the Stockholm stock exchange. Markets are transparent and relatively information-intensive, with many market participants and a strong focus on the individual companies. Stock prices are more likely to incorporate new information faster than the bond market due to the fact that stocks are traded much more frequently than bank or corporate debt. An advantage of the use of stock market data is that the quality is better than debt market data. An additional advantage is the larger quantity of available stock data as compared to debt market data. As mentioned above, empirical results from the use of different market-based indicators are essential in the process of incorporating them into the stability analysis. Hence, when the Riksbank decided to incorporate market-based indicators into the financial stability analysis, the stock market was the first to be considered.

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Equity prices

Equity prices are simple indicators that can be used to compare the development between different banks. The notion that central banks and regulatory authorities could use information from stock prices was first put forward by Pettway (1980). Pettway found, in a small sample of US banks, that stock returns of banks destined for failure signalled problems almost 38 weeks before regulators began their examination process which led to the bank being classified on the problem bank list. A more recent empirical study found that stock prices are relatively more efficient in reflecting firm-specific information than bond prices.¹⁰

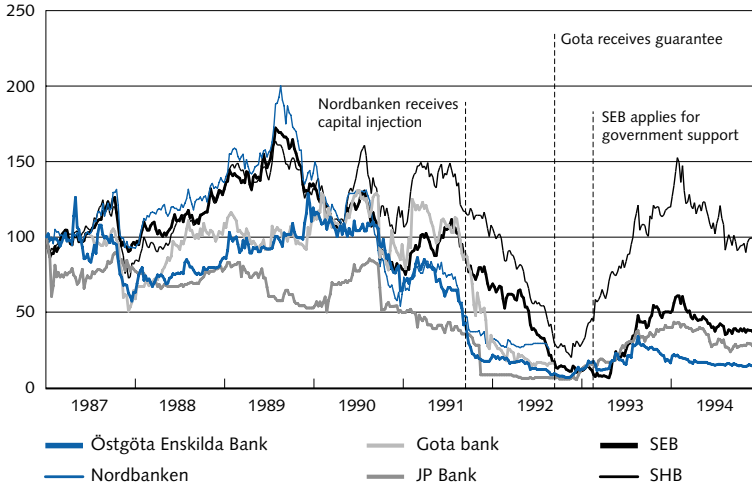
Although the main appeal of using stock prices is that the data is readily available, one shortcoming is that the link between stock prices and default risk is not absolutely clear. Stock prices should reflect the discounted value of all future dividends and an increase in the future profitability of the bank should increase the value of equity today. Likewise, a

¹⁰ See Kwan (1996).

decrease in the future profitability should lead to a lower value of equity today. Hence, there is no unambiguous link between stock prices and default risk, because movements in bank stock prices are driven also by other factors besides default risk. Figure 3 shows equity prices (re-scaled) for a sample of Swedish banks for the period 1987 to 1994 on a weekly basis. The equity prices for all six banks fell dramatically during the banking crisis (see Figure 3). However, it seems that the failed banks fell well in advance as compared to the non-failed banks during the crisis.

There is no unambiguous link between stock prices and default risk, because movements in bank stock prices are driven also by other factors besides default risk.

Figure 3. Equity price developments for Swedish banks 1987–1994
Price indices



Note: Equity prices are re-scaled and adjusted for splits and dividends.

Sources: SIX Trust and the Riksbank.

A further step is to analyse whether stock prices contain any signals about bank health that can be discerned by looking at stock returns instead of the price levels. In order to analyse if there were differences in returns between the banks that ran into problems during the Swedish banking crisis and those that did not, we constructed two value-weighted portfolios. The first portfolio contains the banks that *survived* the banking crisis, that is, the portfolio includes Östgöta Enskilda Bank, JP Bank and SHB. Portfolio 2 consists of the *failed* banks, that is, Gota Bank, Nordbanken and SEB. Summary statistics of the annualised weekly returns for the two portfolios during the period January 1987 to December 1989 are displayed in Table 1. During this period there is no significant difference between the two portfolios, the annualised mean returns are the same but the volatility of portfolio 1, the surviving banks, is higher than the volatility of portfolio 2, that is, the portfolio of *failed* banks (see Table 1).

A further step is to analyse whether stock prices contain any signals about bank health that can be discerned by looking at stock returns instead of the price levels.

**TABLE 1. SUMMARY STATISTICS OF VALUE-WEIGHTED PORTFOLIO RETURNS
JANUARY 1987 TO DECEMBER 1989**

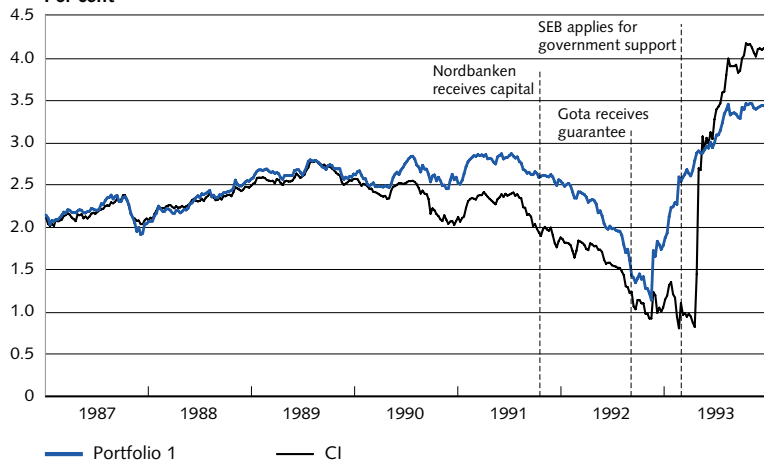
	Portfolio 1	Portfolio 2
Mean return	0.15	0.15
Standard deviation	0.24	0.21

Note. Annualised mean returns and annualised standard deviation of weekly stock returns. Portfolio 1 consists of Östgöta Enskilda Bank, JP Bank and SHB. Portfolio 2 includes Gota Bank, Nordbanken and SEB. Both portfolios are value-weighted.

In order to analyse if there were any differences between the two portfolios, we computed the cumulative weekly returns for the two portfolios (see Figure 4). The cumulative returns of the two portfolios are similar over the period up to 1990, but then the two curves start to diverge. Thus, it appears that the equity returns in the value-weighted portfolio of *failed* banks developed completely differently after 1990. Hence, it seems like the market priced the two portfolios differently after 1990. If the market were able to distinguish the more risky portfolio from the less risky portfolio, then a higher discount rate for portfolio 2 would, *ceteris paribus*, result in lower returns for portfolio 2 as compared to portfolio 1. It is also obvious that the two curves are close to each other during the autumn 1992, which probably reflects not only the currency crisis but also the fact that the crisis had become systematic and that the market realized that at this time.

In order to test if there are any significant differences in the cumulative returns between *survived* banks and *failed* banks, we calculate the difference in cumulative returns between portfolio 1 and the cumulative

**Figure 4. Cumulative weekly returns for portfolio 1 and portfolio 2, 1987–1993
Per cent**



Note: Cumulative weekly returns for portfolio 1 (Östgöta bank, JP Bank and SHB) and portfolio 2 (Gota, Nordbanken and SEB).

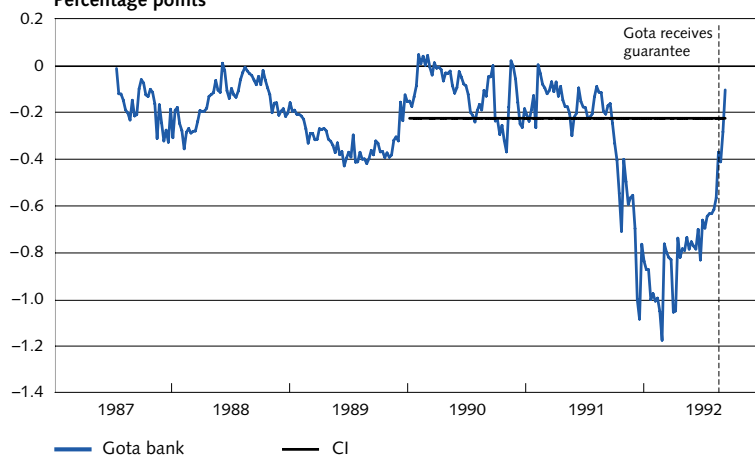
Sources: SIX Trust and the Riksbank.

returns of each bank stock in portfolio 2. That is, we calculate the difference in the cumulative weekly return between portfolio 1 and Nordbanken, and likewise for Gota Bank and SEB. This is done since the event window is overlapping for the banks that went into a distressed period during the Swedish banking crisis. The overlapping event window implies that the individual securities are correlated in the cross section and hence, the distributional results for abnormal returns are not applicable.¹¹ Hence, in order to obtain an estimate of the standard deviation of the difference in weekly cumulative returns we estimate the standard deviation for the difference over a period that can be classified as "normal". The standard deviations of the cumulative weekly return difference between bank *i* and portfolio 1 is estimated for the period January 1987 to December 1989 using the weekly observations, during this period the developments of the two portfolios were similar with almost identical mean returns and standard deviation (see Table 1 and Figure 4).

Figure 5 shows the cumulative weekly return difference between Gota Bank and portfolio 1, that is, the portfolio of non-failed banks. The dotted line shows the lower confidence interval on the 95 per cent level. The cumulative weekly return difference between Gota Bank and portfolio 1 is quite volatile over the period; still the difference between the two is significantly different up to 112 weeks before the bank received the guarantee. Thus, it seems like the returns signal a difference between Gota Bank and portfolio 1 well in advance of the crisis. Figure 6 shows the cumulative weekly return difference between Nordbanken and port-

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Figure 5. Cumulative weekly return difference between Gota bank and portfolio 1
Percentage points



Note: CI denotes the critical value on the 5 per cent level.

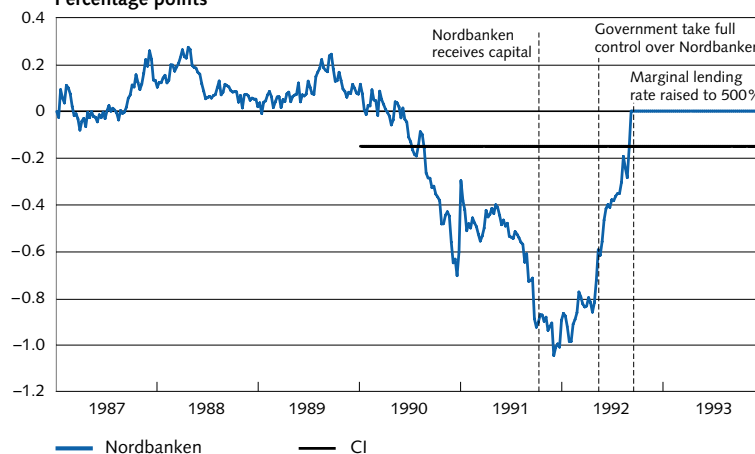
Sources: SIX Trust and the Riksbank.

¹¹ See Campbell, Lo & MacKinlay (1997).

folio 1, and Figure 7 the cumulative return difference for SEB. The cumulative return difference between Nordbanken and portfolio 1 is positive before the middle of 1990, thereafter the return turns downwards and turns to negative during January 1990. In fact, the return difference is significant for Nordbanken in July 1990, more than one year in advance of the capital injection during the autumn 1991.

For SEB, the difference is significant from June 1990, that is, well in advance of the fragile situation (see Figure 7). Thus, the difference is sig-

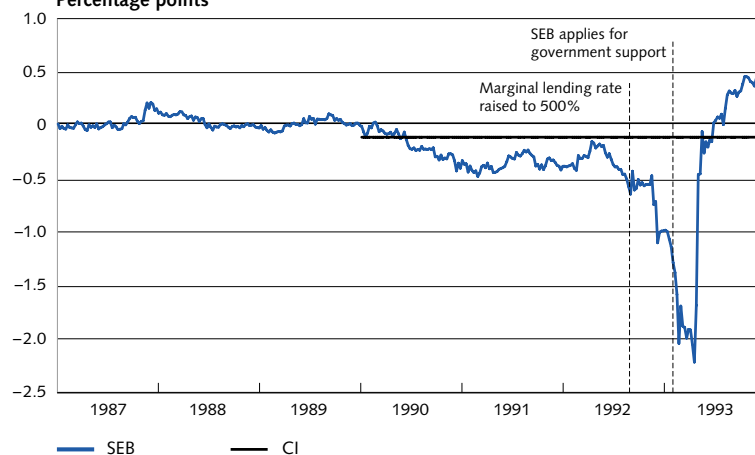
Figure 6. Cumulative weekly return difference between Nordbanken and portfolio 1
Percentage points



Note: CI denotes the critical value on the 5 per cent level.

Sources: SIX Trust and the Riksbank.

Figure 7. Cumulative weekly return difference between SEB and portfolio 1
Percentage points



Note: CI denotes the critical value on the 5 per cent level.

Sources: SIX Trust and the Riksbank.

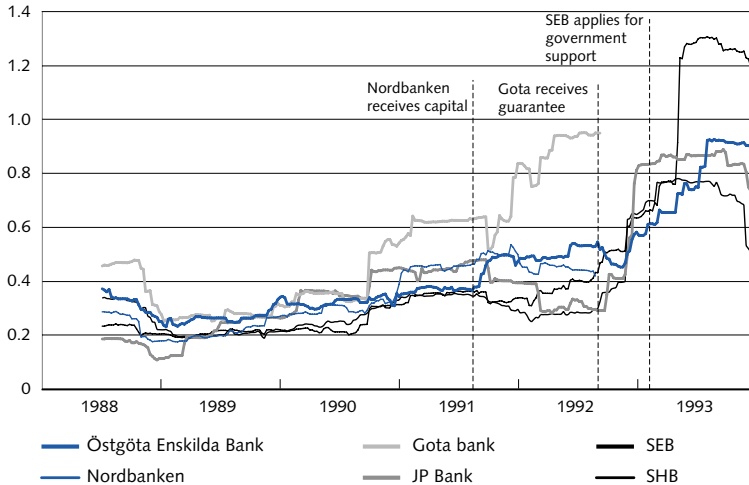
nificant almost three years in advance of the application for government assistance. Hence, stock returns of failed banks developed much differently as compared to non-failed banks before and during the actual banking crisis occurred. Even if all banks had negative returns during the period, the differences in cumulative returns are significant well in advance of the crisis. Stock returns signal significant differences between *failed* and *non-failed* banks up to almost three years in advance. Therefore, it seems like the market to some degree discounted the banks differently, and were able to distinguish more fragile banks from more healthy banks. Our results are well in line with, for example, Elmer & Fissel (2001) who also find that stock returns can help forecast bank failures in the US. Berger, Davies & Flannery (2001), find that supervisory assessments are generally less accurate than equity market indicators in anticipating changes in financial performance, such as earnings, except when the supervisory assessments are based on a very recent inspection.

For SEB the difference is significant almost three years in advance of the application for government assistance.

A further effort in extracting information from the stock market looks beyond the price level and focuses on the volatility of stock returns. Since stocks are residual claims on the bank's assets, the volatility in stock returns contains information about the banking firm's asset risk. An increased asset risk would lead to increased stock price volatility. The annualised volatility of the stock returns based on a 50-week estimation period is shown in Figure 8. The volatility of the banks that later went into a distressed situation is, on average, higher than the volatility of the banks that survived. Furthermore, it is evident that the volatility of banks destined for failure is

It is quite evident that the volatility of banks destined for failure is higher than non-failure banks well in advance of the crisis.

Figure 8. Annualised volatilities 1988–1993
Per cent



Note: Annualised volatility of stock returns based on a 50-week rolling estimation period.

Sources: SIX Trust and the Riksbank.

higher than non-failure banks well in advance of the crisis, and the largest changes in volatility during the period 1990 to 1993 occurs for banks that went into a distressed situation during the banking crisis, thus indicating a difference in default risk between failing and non-failing banks.

The results are well in line with the results in Persson (2003). Persson finds a significantly higher volatility for banks destined for failure during the Nordic banking crisis up to two years before the actual failure, as compared to the volatility of non-failed banks.

Volatility is one of the main market-based indicators used today by the Riksbank in its financial stability analysis.

Volatility is one of the main market-based indicators used today by the Riksbank in its financial stability analysis. Today, we are also able to further improve and extend our volatility estimates since the four large banks have options traded on their stocks. If we use option prices we can improve our estimates by calculating the implied volatilities from the option prices. Implied volatility does not inform us completely about bank risk in the sense of probability of default. Rather it provides us with a measure that reflects the market's view regarding the volatility of the market value of equity, which in turn reflects the market's view of the volatility of a bank's assets. Nevertheless, since asset volatility is directly related to default risk, this indicates that implied volatilities are an important dimension of a bank's default risk. Swindler & Wilcox (2002) find that implied volatilities contain information over and above that contained in stock returns and subordinated debt yields. Hence, implied volatilities both improve our volatility estimates and give us additional information.

The implied volatilities are calculated from exchange-traded put and call options.

The implied volatilities are calculated from exchange-traded put and call options, and only options with at least five days to the exercise date are incorporated in our implied volatilities. Options with a shorter time period than five days left are excluded in order to assure that the estimated volatility is not based on options with no trading. The average implied volatilities for the four large banks for 1999 to 2003 are displayed in Table 2. The implied volatilities are themselves quite volatile over the period. It is interesting to note that the market consistently, during the sample, discounts a higher volatility for both SEB and Nordea.

TABLE 2. AVERAGE IMPLIED VOLATILITIES 1999–2003
PER CENT

	SEB	SHB	Nordea	FSPA
1999	41.73	32.71	40.52	37.00
2000	34.23	30.21	37.45	30.88
2001	32.90	28.13	34.15	30.97
2002	38.03	30.43	41.36	31.37
2003	44.88	33.03	50.42	36.14

Note. Average implied volatilities based on daily implied volatilities. The average Implied volatilities for 2003 are based upon data until 7 April.

A further improvement in extracting information from market prices is based on option-pricing theory, and treats the equity as a call option on the company. This approach relies on the fact that under limited liability, equity is equivalent to a call option on the issuer's assets. With the analogy to options, the technology of option pricing can be brought to bear, and information on investors' implicit views of risk can be extracted from stock prices. Merton (1974) first shows that equity can be modelled as a call option on the assets of the firm, that is bank, with an exercise price equal to the total book value of the debt. The shareholders do not receive anything if the face value of debt at maturity exceeds the market value of assets. Otherwise, they receive the difference between market value of equity and debt. The market value of equity therefore is

$$MV_{Equity} = \max[MV_{Asset} - Debt, 0]$$

Thus, option-pricing theory can be applied to derive the market value of assets and the volatility of assets from the observed market value of equity (MV_{Equity}), volatility of equity (σ_E) and the Debt (D). By applying the standard formula of Black & Scholes (1973), the market value of equity can be valued as:

$$MV_{Equity} = MV_{Asset} N(d_1) - De^{-r t} N(d_2)$$

$$\sigma_E = \frac{MV_{Asset}}{MV_{Equity}} N(d_1) \sigma_{Assets}$$

Where $N(\bullet)$ represents the cumulative normal distribution, r the risk free rate of return and t the time to maturity of the debt. The approach taken by the Riksbank is similar to the one proposed in Gropp et al. (2002). We work out the market value of assets and volatility of assets from the observed equity value, total debt and the volatility of equity.¹² Using these estimated parameters we obtain the future probability distribution of asset to liability ratio and the implied probability of default. The measure we use as an indicator is the distance-to-default, which indicates the number of standard deviations from the default point at maturity.

As inputs into the calculations we use the monthly market value of equity, and equity volatility is estimated as a moving average of the standard deviation of daily returns. The moving average is used in order to reduce noise in the volatility estimates.¹³ The time to maturity of the debt structure is set equal to one year. During the period 1980 to 1995

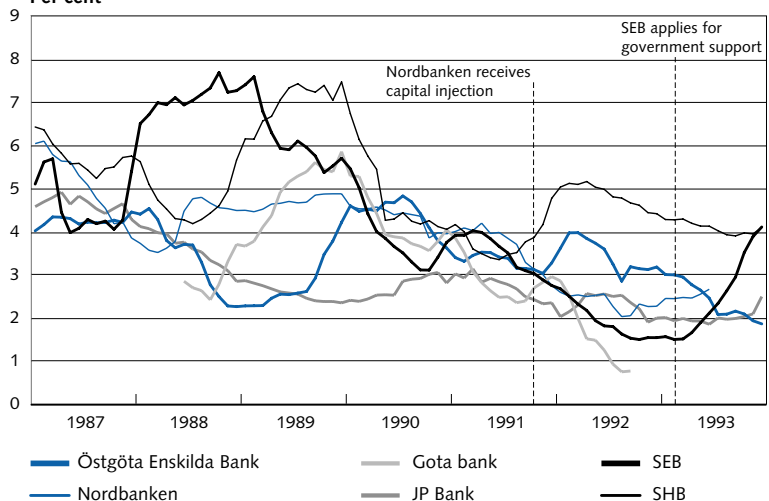
¹² A non-linear goal optimizing routine in Matlab is used to solve for MV_{Assets} and σ_{Assets} .

¹³ The calculations are highly dependent on the estimated volatility, and it might be better to estimate a parametric model of the volatility.

The distance-to-default seems to signal increased fragility and, furthermore, is able to distinguish between failing and non-failing banks.

the monthly balance sheet data delivered to the Riksbank from the banks was used to obtain the monthly total debt of the banks. Total debt is actually biased downwards, since the debt from the banks' subsidiaries are excluded. Figure 9 displays the distance-to-default during January 1987 to December 1993. The distance-to-default for the banks, who reached a fragile situation during the Swedish banking crisis, started to fall in 1990, whereas the distance-to-default for SEB had already started to fall in February 1989. The consistently low value for JP bank is driven by a low value of market value of equity to total debt and a high volatility. In general, the distance-to-default for *failed* banks signals problems before the problems were realized. It should be noted that the Riksbank does not use the distance-to-default as a level measure, rather we concentrate on changes in the distance-to-default. The reason behind this is that we think changes are more informative than levels. Furthermore, it is hard to have a priori opinions on what a reasonable level should be. The major changes in the distance-to-default in Figure 9 occur mainly in banks that came into a distressed situation during the banking crisis. For SEB the distance-to-default started to decline as early as 1989, almost four years before the bank applied for state support, while for Gota Bank the decline in the distance-to-default, that is, the increased probability of default, started in early 1990, almost two years before the bank received state support. Hence, the distance-to-default seems to signal increased fragility and, furthermore, is able to distinguish between *failing* and *non-failing* banks.

Figure 9. Distance-to-default for Swedish banks during the Swedish banking crisis
Per cent



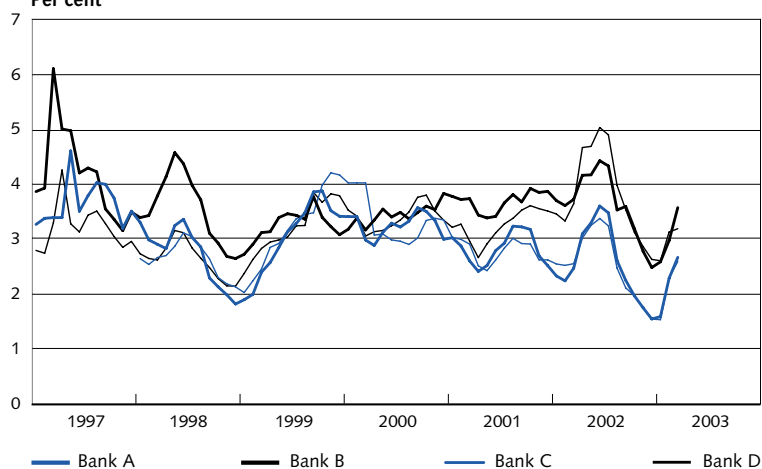
Note: A lower value indicates a higher probability of default.

Source: The Riksbank.

Today, the Swedish banks' subsidiaries have grown in importance, in particular through cross-border mergers. This means that we cannot use the balance sheet data of the parent bank, since the stock price reflects the asset risk in the group as a whole. The total debts in the banks are therefore obtained from the banks' quarterly reports. The quarterly observations of total debts are then converted to monthly observation through interpolation. The distance-to-default for the four large banks today is presented in Figure 10. The distance-to-default for the banks is quite stable over the years. Two banks are more risky according to the indicator, Bank A and Bank C, as compared to the other two banks. This observation could also be seen in the implied volatilities above. Thus, there seems to be a consistency between the two measures, and both measures signal an increased risk in the banking sector since autumn 2002. The change in levels between Figure 9 and Figure 10 is explained by the fact that different sources and different aggregation levels are used in the calculations of total debt. Figure 9 is based on the monthly reported balance sheet data, where subsidiaries are excluded, while in Figure 10 total debt is based on the quarterly reported balance sheet for the holding company.

Both measures signal an increased risk in the banking sector since autumn 2002.

Figure 10. Distance-to-default 1997–2003
Per cent



Sources: Bloomberg and the Riksbank.

Market indicators of corporate sector risk

As mentioned in the introduction, the Riksbank uses market indicators not only for banks, but also for the corporate sector. This, of course, is done in order to obtain the markets' assessment of the risk in the corporate sector, which should reflect the corporate sector risk in the credit portfolios of the banks. In order to assure consistency in the work on incorpo-

rating market-based information in the financial stability analysis, we use the same type of market-based indicators on the corporate sector. One difference is that the analysis of the corporate sector is targeted at industries rather than at individual companies. Still, it is important to recognize that market-based indicators only reflect the risk in a limited number of larger companies, since a large proportion of the companies in the banks' portfolios do not issue bonds and do not have stocks traded on the stock exchange. However, the corporate bond and stock market reflects the market view and expectations of the larger companies, which should also implicitly reflect to some degree the expectations of an industry as a whole, and possibly also lead the development of the non-listed companies in a particular industry.

A first measure of the risk in the corporate sector is obtained from credit spreads on corporate bonds.

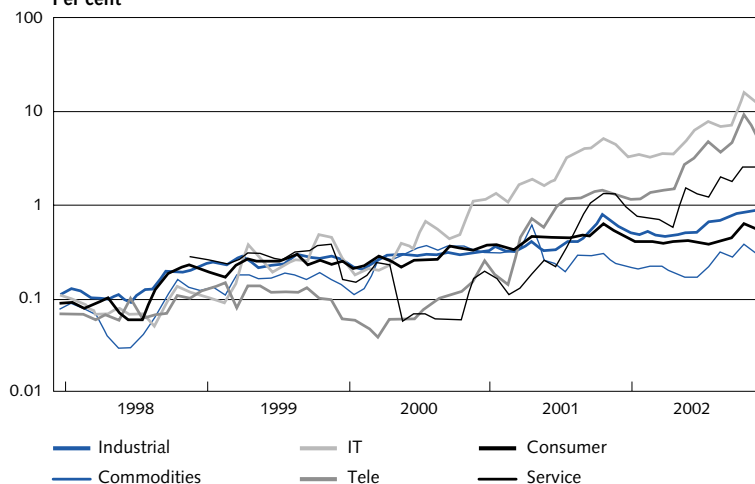
A first measure of the risk in the corporate sector is obtained from credit spreads on corporate bonds. The market for corporate bonds is more liquid than the market for subordinated debt, but the number of issuers is still quite small. In order to obtain a more forward-looking measure of the markets' expectations of the risk in the corporate sector, we use also the equity market. Through the equity market we use the issued options and calculate implied volatilities based on a broad Swedish stock market index, OMX. The credit spreads and implied volatilities are complemented by the use of a measure similar to the distance-to-default measure used for banks. Moody's KMV has commercially implemented a variant of the options-based model based on the same theory as the distance-to-default measure. Crosbie (1999) describes the Moody's KMV approach, in which the Expected Default Frequency, EDF, credit measure serves as a summary measure of default risk. The EDF is a measure of the implied default risk for a company or indices based on both equity and accounting figures. In essence, the EDF measure for a firm represents an estimate of the percentage of firms in the same financial condition that historically defaulted on an obligation within the next twelve months. We use KMVs EDF credit measure on industry indices in order to measure and follow developments of the credit risk on an aggregated industry level.

The risk has increased in general during 2002, and in particular in the telecommunication and IT sectors.

Figure 11 displays the EDFs for seven broad indices on the Swedish stock market. The risk has increased in general during 2002, and in particular in the telecommunication and IT sectors. The observation from Figure 10, that the risk in the banks has increased in the latter part of 2002, could be a consequence of increased risk in the corporate credit portfolio. The fact that the banks' distance-to-defaults move in the same direction, in general and as expected, implies that further knowledge behind what drives the distance-to-defaults for banks can probably be obtained by also looking at a similar measure for the corporate sector. It should be noted, however, that the consistency between the corporate

sector signals and their impact on the Swedish banks and the signals from market-based indicators have not yet been fully analysed, although this approach is now under development at the Riksbank.

Figure 11. EDFs for seven industries 1997–2002
Per cent



Note: Equally weighted indices constructed using Affärsvärldens industry indices and in logarithmic scale.

Sources: KMV Corporation and the Riksbank.

Conclusions

The Riksbank's view is that market information contains a lot of information about risks in banks and in the corporate sector. Empirical studies generally show that market indicators can signal increased risk efficiently and well in advance of the occurrence of events such as rating downgrades or actual failures. More specifically, a check of the indicators from the period of the Swedish banking crisis indicates that markets signalled the coming problems before the public debate began to focus on them. In essence, the markets give the right signals, and the information they provide is not redundant. For the corporate sector analysis, market indicators make it possible to follow the risk-level in particular industries and to make comparisons between different national markets, without in-depth knowledge of any one of these.

For the Riksbank, market indicators are important as a complement and a reference point for the conventional analysis. If markets signal that the level of risk in a particular bank or an industry is increasing, the Riksbank can compare this signal with its own assessment. If there is a big difference, it is necessary to evaluate the reasons behind this more profoundly.

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Type-II errors seem to exist when looking at market indicators. This is another reason why it may be difficult to use them without evaluating them against the conventional analysis. However, in establishing any early-warning system, the desire is to minimise the misclassification of problem banks as non-problem banks (type-I error). To obtain classification information early, we should be willing to accept a higher type-II error (classifying non-problem banks as problem banks) to gain a lower type-I error. Additionally, the type-II misclassification error would only place healthy banks under closer inspection and analysis. This, of course, entails some cost. However, if only a few non-problem banks are misclassified the gain from early knowledge and early classification of potential problem banks would enhance the analysis further.

The Riksbank has chosen mainly equity-based indicators because of the better quality of data.

The Riksbank has chosen mainly equity-based indicators because of the better quality of data, in particular when it comes to liquidity, and the absence of too-big-to-fail problems with banks. The evidence from Swedish data gives strong support for this standpoint.

The main indicators that the Riksbank makes use of at present are:

- implied volatilities (for banks and the corporate sector),
- distance-to-default (for banks) and
- KMV EDFs on the level of industries (for the corporate sector).

The use of market indicators at present in the Riksbank can be seen as quite low, but they are expected to grow in importance when they have been tested for a longer period.

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