Interbank exposures and systemic risk[1]

Martin Blåvarg and Patrick Nimander

1. Background

Sweden underwent a severe banking crisis in the early 1990s. One of the lessons drawn was that the authorities were ill-prepared to deal with this type of situation, with regard to both crisis management and crisis prevention. After the crisis, in the mid-1990s, the Riksbank started to develop a new framework defining what its role as a non-supervisory central bank should be regarding financial stability.[2]

The starting point for this framework was that the central bank role, as well as that of other public interests in the financial sector, was built upon the existence of systemic risk. Without dwelling too much on the concept of systemic risk, it can be said that it exists because of the combination of two important factors. Firstly, the financial sector in general, and the payment system in particular, is very important for the functioning of the economy. A breakdown of the financial system will most likely carry substantial socio-economic costs. Secondly, the financial system, especially the banking system, is vulnerable to external shocks. Basically, depositors relate this to the fact that banks fund illiquid loans with liquid deposits, which makes them vulnerable to loss of depositor trust, which may lead to withdrawal of funds. Moreover, financial problems in one bank may spread to other banks and lead to losses and consequential failures of other banks (contagion). This combination of high probable social costs of failure and high fragility in the banking system is the main motive for regulating banks, according to the Banking Law Commission, which was set up with the purpose of reforming bank regulation in Sweden after the crisis.[3]

Risk of contagion between banks is thus an important element of systemic risk. Contagion in the banking system can typically be divided into direct and indirect contagion. Direct contagion arises because banks are financially exposed to one another, both through the payment system and through other types of positions such as outright loans, derivatives, repurchase agreements, etc. Indirect contagion can arise mainly through two channels. Firstly, markets may assume that direct contagion effects exist, even where this is not the case. Secondly, if one bank is struck by financial problems, markets may expect that other banks in the same system will be hit by the same problem, which in turn can lead to the other banks suffering a run by depositors.

Although risk of contagion is crucial as a motive for public interest in banking systems, it is striking how little this is reflected in regulatory systems. Regulation and supervision are to a very large extent directed at avoiding the failure of individual banks rather than the failure of the system as a whole.[4] Even if indirect contagion may be hard to influence by regulation or supervision, that should not be the case for direct contagion. In the area of payment systems, the main focus of the authorities is on the possible contagion effects that may arise due to the construction of the system. During the 1990s, a large majority of developed countries focused on using RTGS (real-time gross settlement) and DVP (delivery-versus-payment) mechanisms for making payment and settlement systems robust to individual bank failures and diminishing direct contagion effects through the system. However, little attention has been paid to the contagion effects arising outside the payment system. Many of the relevant interbank markets grew substantially during the 1990s. Global turnover on derivatives markets nearly doubled between 1995 and 2001, and turnover in foreign exchange markets more than

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[1] An earlier version of this article was published in Sveriges Riksbank's *Economic Review*, no 2, 2002, pp 19-45.

[2] A description of the emergence of the Swedish banking crisis and how it has affected the authorities' monitoring and regulation of the banking system is given in Andersson & Viotti (1999).

[3] The Commission's proposal is presently under consideration by the Government. For a brief description of the proposal, see Lind & Molin (1999).

[4] See Acharya (2001) for a discussion on the scope for directing bank regulation to systemic risk rather than individual banks.

doubled between 1989 and 2001 (even though turnover in these markets has decreased over the last few years).[5] The higher turnover makes it probable that interbank exposures have grown as well.

The most obvious way for authorities to limit direct contagion effects would be to set regulatory limits for the size of the exposures banks were allowed to have towards one another. Most countries have rules regarding large exposures, but these are mainly set up in order to limit concentrations in banks' lending portfolios. In the EU regulatory framework, banks are not allowed to have individual counterparty exposures larger than 25% of their capital base. However, short-term exposures of less than one year between financial institutions are exempted from these rules.[6] It is common to regard the need for banks to take on large exposures to each other as an unavoidable part of their business, since they are intermediaries on interbank markets with very large flows, such as the foreign exchange and derivatives markets. The potential for direct contagion effects are thus often considered as natural.

In the field of research, the lack of data has been a general obstacle. Some work has been done on empirical measurement of contagion risks,[7] but to our knowledge there is nothing covering all interbank exposures, simply because data is not available. The lack of data is naturally connected to the low interest in this issue in the regulatory system. If supervisors do not demand the reporting of these exposures, no reporting data that can be used for research will be available. The banks' incentives to perform research themselves or provide data to outsiders are weak. Data on counterparties is normally not given freely, as this would disclose important information on the business of the bank. The incentives for banks to show their exposure to direct contagion effects may be weak, since this exposure may be one reason why the authorities may protect them in a crisis. Another reason for the lack of data in this area is simply that banks may not have felt any call to show this type of data, either from investors or supervisory authorities.

When developing the new financial stability framework at the Riksbank and trying to focus on systemic risk, the gap between the emphasis on contagion in theory on the one hand and the lack of regulatory initiatives or empirical research on the other hand was identified as a major area of concern. The Riksbank therefore wanted to develop an empirical base for estimating the effects of direct contagion. Even though the Riksbank is a non-supervisory central bank, it has a quite unique opportunity to collect information directly from financial institutions, since it has a legal right to demand any information from Swedish financial institutions. This article describes the kind of data that has been collected with the objective of analysing direct contagion effects, as well as presenting some quantitative results and drawing some conclusions as to how public authorities could deal with direct contagion.

2. Measurement of direct contagion

This section describes some of the issues that were important when the reporting of interbank exposures was developed at the Riksbank. In terms of procedure, the design of reporting was drawn up after a quite thorough investigation into the kinds of exposures Swedish banks had, what risks different types of exposures led to, how variable these exposures were over time, etc. This investigation was carried out in autumn 1998 and the reporting began in summer 1999.

The problem of direct contagion is normally seen as the risk that failure of one bank will lead to credit losses for other banks that are so great that their solvency is also threatened - if one bank falls, others will follow like a row of dominoes. To answer the question "How large could the losses be for other banks if one bank fails?" was the objective for the Riksbank when measuring direct contagion. There can be any number of reasons for one bank failing; it is just assumed that one bank fails for whatever reason. The approach targets the solvency effects of a bank failure on other banks. Failure of a bank

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5 BIS (2002).

6 Individual countries may have stricter rules than this, but according to a brief survey of some EU countries made by the Swedish Financial Supervisory Authority, no country did. One country monitored interbank credit limits regularly.

7 See, for instance, Furfine (1999).

may also have liquidity impacts on other banks. The focus of the Riksbank's analysis and measurement of direct contagion has been on the solvency effect, which is reflected in the kinds of exposure that have been measured. However, the available data is also used for approximating effects on liquidity (see Section 3.6 Liquidity impact).

The willingness of banks to take on large exposures is quite dependent on the maturity. Banks may consider it fairly likely that they would receive at least some information in advance if an important counterparty were about to fail. If the time to maturity is only one day or a couple of days, it would be possible to withdraw credit exposures if a warning signal of potential failure were observed. An important issue here, therefore, is at what time horizon a bank is expected to fail, as an instantaneous failure would normally be expected to induce much greater losses than a gradual failure. In the payment system area, the focus is normally on the instantaneous failure of a bank. Interbank exposures are often of very short maturity. Interbank deposits, for instance, are predominantly overnight, at least in Sweden. As it may be difficult to measure intraday exposures globally[8] in large banks, the Riksbank chose to measure all overnight exposures, to investigate what would happen if one bank were to fail from one day to another. Although a failure of a large bank from one day to another is an unlikely event, it does happen, the failure of Barings probably being the most prominent example.

Sweden has a concentrated banking system - four large banks cover at least 80% of the system.[9] Because of its focus on systemic risk, the Riksbank concentrates its analysis on these four banks. Contagion could in general be expected to be a bigger problem in a concentrated system, since the large banks have fewer alternative counterparties in the interbank markets. As it is predominantly the failure of one of these four banks that could pose a systemic threat to the Swedish banking system, the measurement of direct contagion was conducted using the largest exposures of these four major banks. As reporting is costly for the banks, it was considered unnecessary to require all banks to do this special reporting. The difference in size between the fourth and fifth bank is so large that it is not possible that failure of one of the smaller banks could cause a loss big enough to become a threat for any of the larger banks. A failure of one of the larger banks could, on the other hand, be a threat for the smaller banks. The data collected cannot be used for analysing these latter effects.

The reporting requirements cover the 15 largest individual exposures. The reasoning behind this is that there should be few counterparties to whom banks are willing to take exposures large enough to threaten their solvency. This hypothesis has been confirmed by data (Figure 1). The size of exposures drops rapidly from the largest to the 15th largest counterparty. The 15th largest counterparty exposure is never of such a size that the failure of that counterparty would threaten the exposed bank.

One issue that was important when setting up the reporting requirements was what kind of exposures should be covered. As the purpose was to analyse what the effects on solvency would be if one of the largest counterparties failed from one day to another, it was decided to focus on exposures containing full principal credit risk. This means that the ranking was based upon uncollateralised exposures. To exclude collateralised exposures is reasonable since one of the most commonly used instruments on the Swedish interbank market is repurchase agreements with government bonds as the underlying assets. In most cases, there would be no losses on these repurchase agreements if a counterparty fails. If these exposures were not excluded, they would risk dominating the data. Collateralised exposures are reported as memo items for the 15 largest counterparties, but they do not comprise the basis for the ranking.[10]

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[8] "Globally" here refers to all business lines and all geographical locations in which a bank is active. Banks generally do not have information systems that record financial exposures on a real-time basis. The exposures are controlled by the setting of credit limits globally on particular counterparties, limits that then are distributed to different business units that may deal with that particular counterparty.

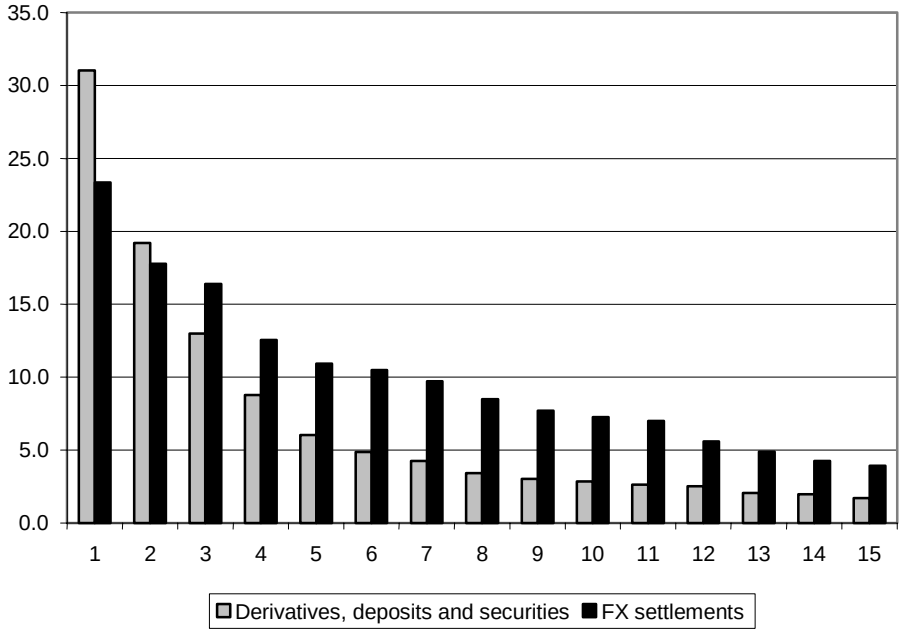
[9] For a description of the structure of the Swedish banking market, see Sveriges Riksbank (2002).

[10] See the reporting tables in Annex 1 for further information.

Figure 1

Swedish banks' exposure to the 15 largest counterparties. Average exposures in relation to total Tier 1 capital

In percentages



Source: Sveriges Riksbank.

The uncollateralised credit exposures that give rise to the size ranking are uncollateralised lending, holdings of securities issued by counterparties and the credit element of derivative exposures.[11] However, full principal credit risk can also arise because of settlement exposures, if payment and settlement systems are not constructed to incorporate PVP (payment versus payment) or DVP mechanisms. Swedish payment and settlement systems incorporate such mechanisms, except for foreign exchange settlement. FX settlement gives rise to a full principal credit exposure lasting on average two days. Outstanding FX settlement exposures are therefore included in the reporting. As these exposures are sometimes substantial compared to other exposures, they are not included in the size ranking of the counterparties, in order not to dominate the ranking. The 15 largest FX settlement exposures are instead ranked separately. By putting the two ranking lists together, the largest counterparties, both including and excluding FX settlement exposures, can then be established. In addition to the ranking of the largest individual exposures, the banks' total exposures within each area have been listed, in order to give a picture of the total size of interbank exposures and how concentrated these markets are.

The reporting also includes the names of each of the counterparties. This is useful for two reasons in particular. By including the names of the counterparties, the Riksbank can see if failure of one bank will affect several other Swedish banks. The names also make it possible to analyse second-round effects of contagion, that is, to construct scenarios with possible chain effects from defaults. The reporting also covers counterparties that are not financial institutions, even though it was expected that it would be mainly financial institutions to which the banks had very large exposures. This expectation has been confirmed; financial institutions dominate the ranking list, although from time to time non-financial companies are included on the lists, as well as financial companies.

[11] The positive market value of derivatives positions that a bank has against a particular counterparty. The relevant contracts are OTC derivatives rather than exchange-traded derivatives, as these exposures are normally secured. Banks often have contracts of both positive and negative value with a particular counterparty. These contracts can be netted against each other if the parties adopt netting agreements. Therefore, both gross and net exposures are reported.

The banks generally do not have information systems that collect financial exposures on a real-time or near real-time basis. Exposures are controlled by the setting of credit limits globally on particular counterparties, limits that are then distributed to different business units which may deal with that particular counterparty. To collect the actual exposures and rank them is quite burdensome and time-consuming for the banks.

As the kinds of exposures that are covered in this reporting are highly variable, it would in principle be interesting to have more frequent reporting. In order not to impose an undue burden on the banks, the Riksbank has limited the requirement to quarterly reporting. The reports are taken in for the end of the quarter, so that they coincide with the dates for financial statements, when actual exposures have to be collected globally within each institution anyway. The low frequency of reporting and the particular dates are of course a limitation for the analysis. Exposures can be expected to vary greatly from one day to another, and they are probably lower at the end of the quarter, since the banks in general do not like to show larger balance sheets than necessary. The Riksbank thus sees the reported exposures as indications of what size the exposures might be, rather than exact figures that are valid over time.

3. Reported counterparty and foreign exchange exposures

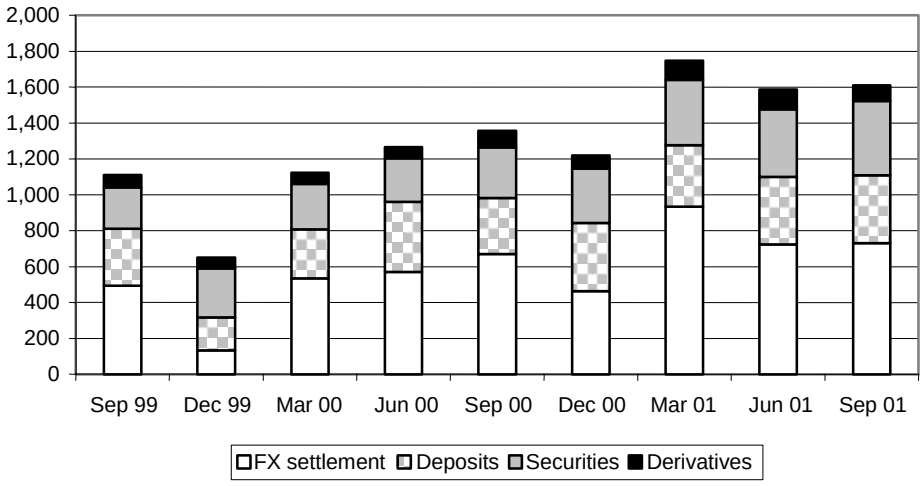
3.1 Overall size of exposures

The overall size of the reported exposures is approximately SEK 1,600 billion during 2001, for the four major Swedish banks.[12] This is a slight increase over the previous year.

Figure 2

Reported counterparty exposures by the four major Swedish banks

SEK billions



Source: Sveriges Riksbank.

The largest exposures are in the foreign exchange (FX) settlement segment, with these exposures normally making up between SEK 490 and SEK 730 billion of total exposures. Deposits have varied

[12] Reported exposures of SEK 1,600 billion can be compared to the Swedish GDP of approximately SEK 2,000 billion.

between SEK 273 and SEK 378 billion and securities between SEK 228 and SEK 414 billion. Derivatives exposure is the smallest class of exposures and has over the years increased from around SEK 60 billion to a high of SEK 110 billion and is now at SEK 87 billion. At the turn of the millennium, exposure levels were much lower, the result of very low levels of exposure to FX settlement and lower than normal exposure to deposits.

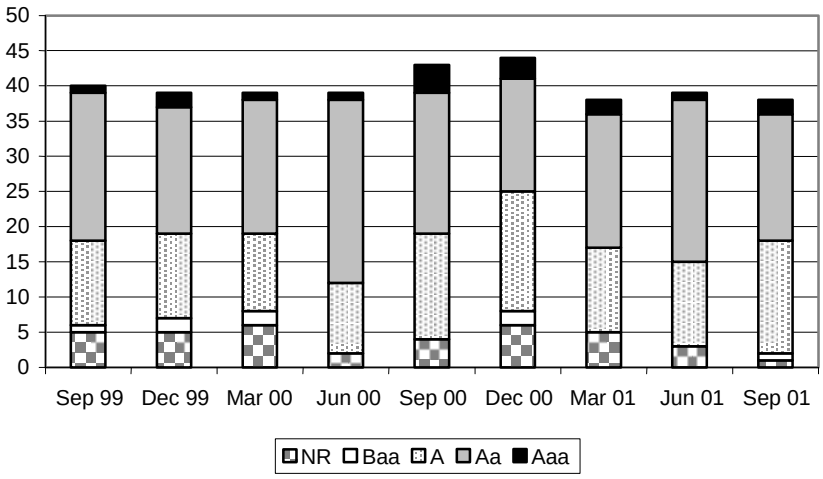
3.2 Counterparty rating

Possibly the banks' foremost means of controlling counterparty risks is to mainly expose themselves to counterparties with a high credit standing and to set limitations for exposures. One method of assessing credit standing is to study Standard & Poor's and Moody's credit ratings for the respective counterparties, as the Riksbank has no internal function for making credit assessments of banks.

The Swedish banks' counterparties have high credit ratings, according to the counterparty statistics. The average credit rating is A1/A+, which corresponds well to the ratings of the Swedish banks. The average credit rating has been at this level since the reports started in 1999.[13] The banks are largely exposed to counterparties with a credit rating of A or higher (Figure 3). There are counterparties with Baa ratings or with no rating from either S&P or Moody's. Counterparties lacking a public rating do not necessarily comprise greater credit risks than those with a rating, since the lack of credit rating could simply mean that they do not borrow directly in the market. Counterparties with no public rating from the rating agencies are normally well known by the banks that are exposed to them. The counterparties' relatively good credit standing indicates a low probability of sudden default among the counterparties.

Figure 3

Number of counterparties by rating category



Source: Sveriges Riksbank; Moody's; Standard & Poor's.

Generally, the counterparties used by the Swedish banks are internationally active foreign financial companies, Swedish and Nordic banking groups and some Swedish large and mid-sized non-financial companies.[14]

[13] Data was first reported for June 1999. In this article, data from September 1999 onwards is included, as the data from June does not fully correspond to the data reported later.

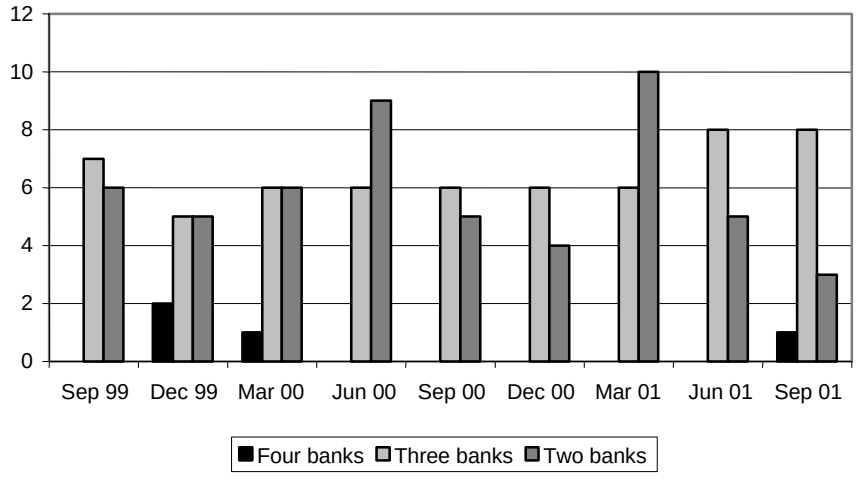
[14] Counterparties reported by a major Swedish bank can, of course, include one or more of the other major Swedish banks.

This confirms what we have seen in our work on credit risk management in the Swedish banks, ie that the Swedish banks actively manage which counterparties they do business with. Normally, limits on exposures are set through the use of ratings on the potential counterparties, either from rating agencies or internal ratings.

The four reporting banks rank their 15 largest exposures, in descending order of size. The maximum possible number of counterparties on each reporting occasion for the four major banks is thus 60. Since September 1999, the number of counterparties used by the banks has varied between 38 and 44 (Figure 3). The banks have little (or no) knowledge of which counterparties the other banks use regularly, and have no knowledge of which banks their competitors are exposed to at present. The number of counterparties reported by the banks indicates that the name concentration is not as big a problem as could have been assumed. The fact that the reported counterparties do not add up to 60 implies that there are counterparties to which more than one Swedish bank is exposed.

Figure 4

Number of Swedish banks exposed to the same counterparty



Source: Sveriges Riksbank.

The fact that more than one major Swedish bank might be exposed to the same counterparty is a possible source of risk concentration in the banking system. There are few counterparties to which all four banks are exposed at any time, but there are a number of counterparties to which two or three of the Swedish banks are exposed at any given time (Figure 4). The few counterparties shared by all four banks are not a major source of concern as they are normally highly rated counterparties to which the banks have lower levels of exposure. The counterparties shared by three of the banks deserve more attention, as this group normally includes several Swedish banks, and possibly could include some financial companies with lower credit ratings.

3.3 Direct contagion effects within the Swedish banking system

In the event of a default by one of the Swedish banks, there is a slight risk of a subsequent failure of another Swedish bank. A subsequent default could occur if one or several Swedish banks suffered such large losses that their capital was reduced below the statutory levels or to such an extent that the bank could not refinance itself in the market. In this paper, a loss big enough to lead to the Tier 1 capital of the bank falling below the required level of 4% is assumed to constitute a default. This is probably quite a conservative threshold.

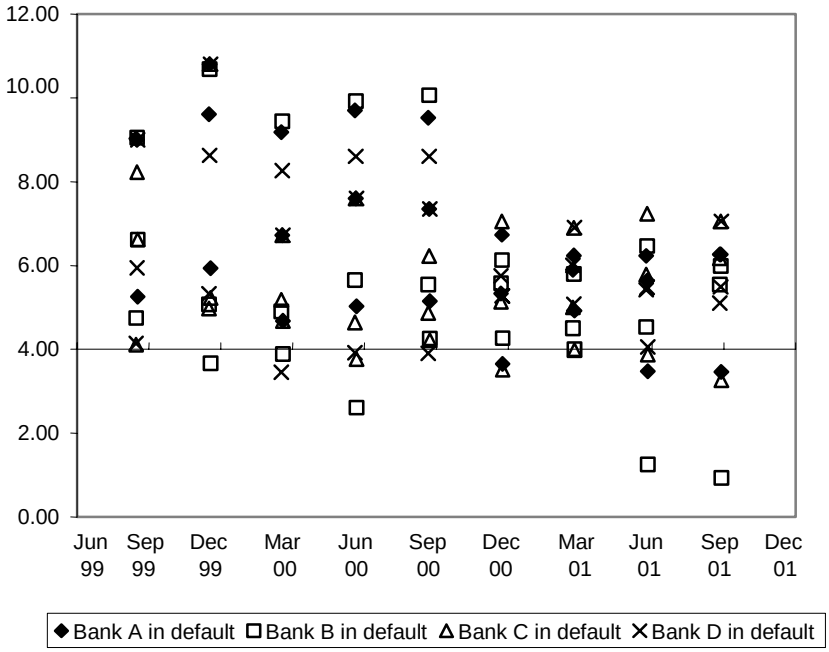
Since September 1999, there have been a number of cases where a Swedish bank has had such substantial exposures towards another Swedish bank that there would have been direct risk of contagion if one of these counterparties had defaulted. In such cases, only if almost the whole of the exposed amount were lost would the exposed banks' capital actually decline sufficiently for direct

contagion to occur. The Tier 1 capital ratios of the Swedish banks declined over the studied period. They were high during the first half of the period as some Swedish banks were in the process of merging or taking over other banks. Higher initial capital ratios give the banks stronger resilience to losses from counterparty exposures. The shift in Tier 1 capital ratios can clearly be seen in Figure 5. The shift occurs between September and December 2000.

Figure 5

Tier 1 capital in Swedish banks after a major Swedish bank default, assuming no recoveries

In percentages



Source: Sveriges Riksbank.

Note: Figures 5 and 6 illustrate Tier 1 capital ratios in the three surviving Swedish banks after one of the other Swedish banks has defaulted; the capital ratio is lowest after a default by Bank C.

On the basis of the reported counterparty exposures and the Tier 1 capital ratios of the Swedish banks, there are 16 cases where the exposed bank's Tier 1 capital ratio would have fallen below the statutory 4% level if one of the other Swedish banks had defaulted (Figure 5). The total number of reported counterparty exposures to date is 108. These 16 cases occur assuming no recovery at all, or full loss of the total exposed amount. Assuming no recovery at all is, of course, very conservative by all standards. If we assume that the losses at default are only 75% of the exposed amounts, or 25% recovery, the number of cases where the Tier 1 capital ratio falls below 4% would be only four (Figure 6).

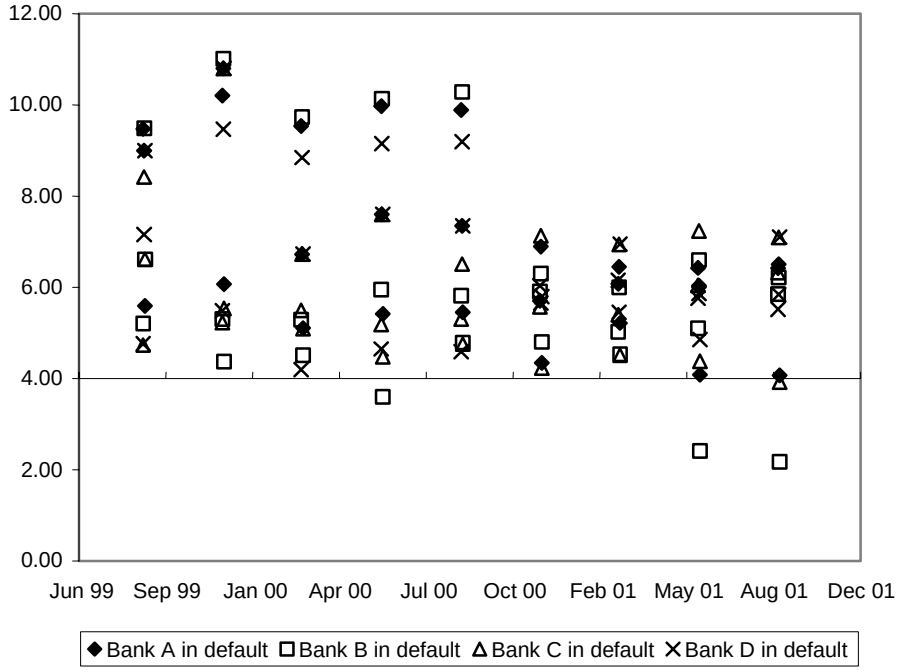
The severity of losses also seems to increase during the latter part of the period for which data is available. This is the effect of decreases in the Tier 1 capital ratios of all the Swedish banks, but also of higher levels of exposure between some of them. The main observation as regards direct contagion in the Swedish interbank markets is that there is a potential for large losses by some Swedish banks if other Swedish banks default. The likelihood of direct contagion in the Swedish banking system is dependent on which of the banks defaults, as there are links between the banks. Depending on which of them defaults the risk of direct contagion varies, as the exposures major banks allow themselves to other banks differ quite substantially. In the event of a counterparty default, it is only major losses with low degrees of recovery that would lead to contagion from one Swedish bank to another, almost regardless of which bank defaults. The risk of contagion effects between the banks is thus relatively

slight, even though a few instances would definitely constitute very severe losses to some of the banks, even forcing the exposed bank into default.

Figure 6

Tier 1 capital in Swedish banks after a major Swedish bank default, assuming 25% recoveries

In percentages



Source: Sveriges Riksbank.

3.4 Direct contagion from abroad

We conclude that the risk of contagion within the Swedish banking system is relatively slight. There could of course be other channels through which direct contagion effects might hit the Swedish banking system. One such channel is the foreign counterparties to which the major Swedish banks are exposed.

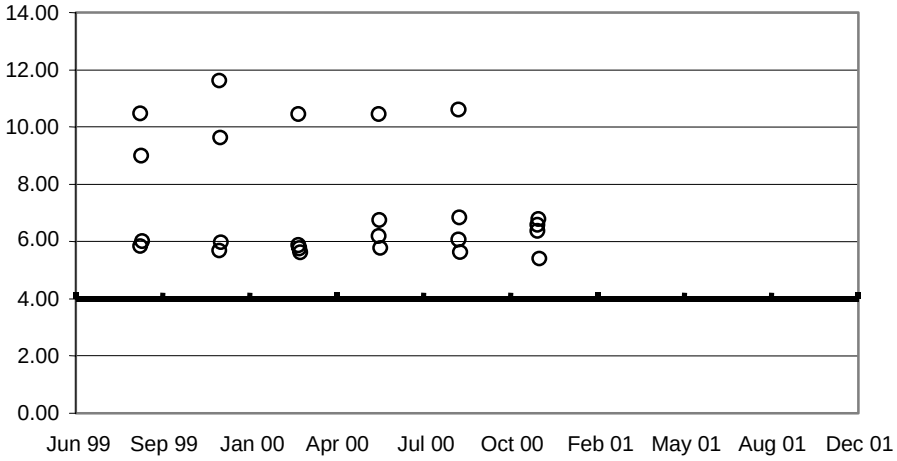
The effects on Swedish banks of a default by their largest foreign counterparty could possibly become a threat to financial stability. We have observed Tier 1 capital ratios for Swedish banks after their largest foreign counterparty has defaulted. In Figure 7, capital ratios are calculated for Swedish banks assuming full loss of the exposed amounts, and in Figure 8 we allow for 25% recovery. There are no instances when the capital ratio falls below the statutory 4% level. The effects on the system from foreign counterparties thus seem to be smaller than the effects from domestic counterparties. The foreign counterparties in these calculations have the same form of ranking as in the section on domestic exposures above.

The severity of losses on the capital ratios of Swedish banks is also lower for the foreign counterparties than for Swedish counterparties. There is a less severe effect with regard to both the number of cases where capital ratios fall below 4% and the actual capital ratios. We can only conclude that the possibility of direct contagion effects from foreign counterparties is very slight for the Swedish banking system.

Figure 7

Tier 1 capital in Swedish banks after the loss of their largest foreign counterparty, assuming no recoveries

In percentages

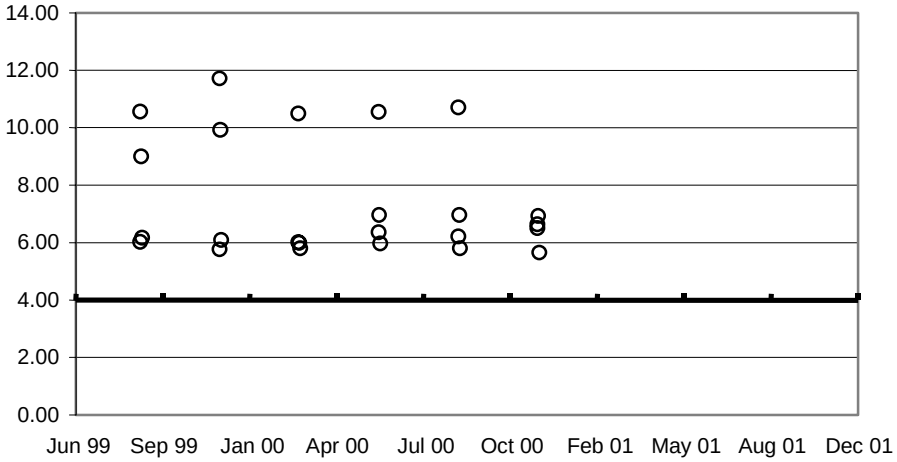


Source: Sveriges Riksbank.

Figure 8

Tier 1 capital in Swedish banks after the loss of their largest foreign counterparty, assuming 25% recoveries

In percentages



Source: Sveriges Riksbank.

3.5 Direct contagion from foreign exchange settlement

FX settlement exposure accounts for almost half of total exposures reported by the banks, which makes these exposures a likely channel for direct contagion. The effects on Swedish banks of losing their largest FX settlement exposures are calculated below. The counterparties in this case are Swedish and Nordic banks, large Swedish non-financial companies and some foreign financial companies.

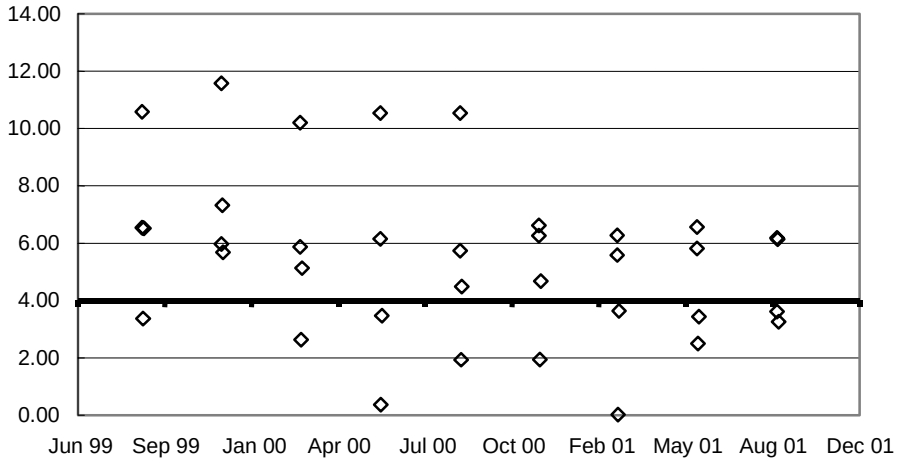
The findings from the calculated Tier 1 capital ratios in Swedish banks after the loss of their largest FX exposures are that no fewer than 12 cases where capital ratios fall below the 4% threshold can be

observed, assuming no recoveries. Assuming 25% recovery on the FX exposures limits the number of instances where the capital ratio falls below the statutory level to six. The number of cases where capital ratios fall below the statutory level when assuming 25% recovery decreases less than in the calculations above. This is because losses incurred by FX settlement exposures are larger than the losses above.

Figure 9

Tier 1 capital ratios in Swedish banks after the loss of their largest FX counterparty, assuming no recoveries

In percentages



Source: Sveriges Riksbank.

The size of FX settlement exposures differs markedly between the four major Swedish banks, as was the case with the size of exposures in the Swedish interbank market. The banks most at risk from FX settlement exposures are not the same banks as those most at risk from exposures to other Swedish banks. The fact that different banks have large exposures in the Swedish interbank market and the FX settlement market reduces the risk of direct contagion from one specific counterparty to several Swedish banks at the same time as the Swedish banks are vulnerable to defaults from different counterparties.

The risk of sequential direct contagion is a consequence of the possibility of one bank losing substantial amounts from the default of a foreign counterparty, the effect being that the bank itself defaults. Default by the first Swedish bank could then trigger another round of defaults among the others. This is the worst case scenario from a direct contagion perspective for the stability of the Swedish financial system.

The effects of FX settlement exposures are possibly the most severe in terms of direct contagion for the Swedish banks. The effect of defaults will diminish when foreign exchange settlement starts using PVP mechanisms within the CLS Bank.[15] The Swedish krona will not be one of the original currencies in CLS, but there are beneficial effects from trading USD/EUR on a PVP basis (Figure 11). The EUR/USD exposures reported by Swedish banks account for 19% of the total exposures, or SEK 125 billion. The effects of the krona being traded in the same way can also be assessed from Figure 11; exposures including the krona and one of the original currencies are at least 63% of total exposures and could possibly be even larger.[16] The effects of PVP in foreign exchange settlements would also

[15] For a description on CLS and how it will diminish settlement risk in foreign exchange trading, see Sveriges Riksbank (2001).

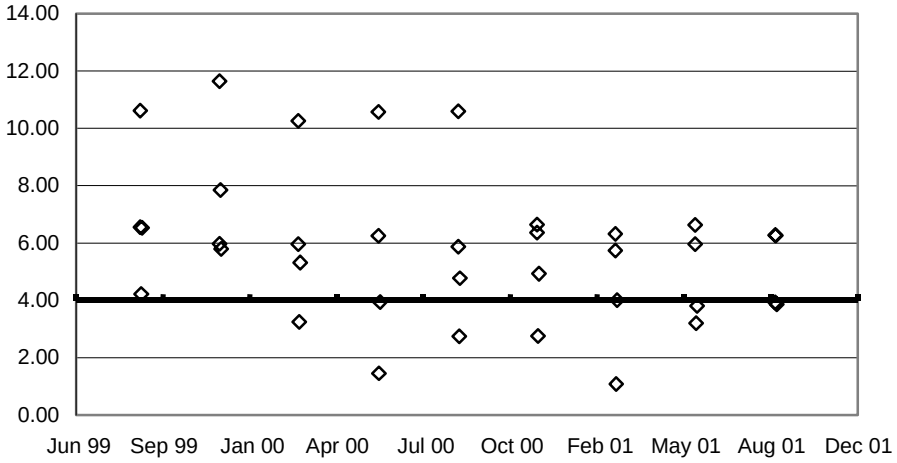
[16] Adding the exposures that are known to include SEK, USD and EUR, 11% + 33% + 19% = 63%.

reduce the level of exposures in the domestic interbank market and to foreign counterparties, as these markets also include FX settlement exposures to some extent.

Figure 10

Tier 1 capital ratios in Swedish banks after the loss of their largest FX counterparty, assuming 25% recoveries

In percentages

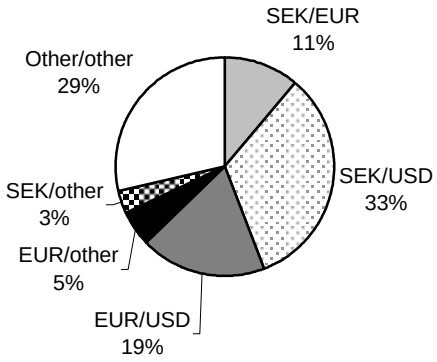


Source: Sveriges Riksbank.

Figure 11

Currency pairs

September 2001



Source: Sveriges Riksbank.

3.6 Liquidity impact

So far, the focus of the analysis of direct contagion has been on the solvency effect (ie the size of the loan loss) on Swedish banks, should one of their major counterparties default. A sudden default by a major counterparty would also comprise a liquidity effect, since repayment of the relevant claims on that counterparty would not occur. The potential liquidity impact on banks from counterparty exposures is hard to estimate, as the Riksbank's report does not cover the duration of the exposures. One can

assume that the majority of exposures are of very short duration, but the duration of securities and derivatives could potentially be quite long. We therefore make the assumption that we can approximate the effects on the exposed banks' liquidity of a counterparty default by looking at the FX settlement and deposit classes of exposures. FX settlement exposures typically last for a maximum of two days. According to a survey of Swedish banks in 1998, the majority interbank deposits in Swedish banks are overnight and very few mature in more than one month. When assessing the liquidity effect on banks, it thus does not seem overwhelmingly conservative to assume that the total exposure in FX settlement and deposits to a single counterparty will be due for payment at very short notice.

Assessing the liquidity impact has so far not been part of the ongoing work at the Riksbank, but will be included in the future. Here, only a very simple calculation of the liquidity impact will be performed. The methods for doing this could probably be enhanced significantly. The effects on the liquidity of the Swedish banks have been calculated by comparing the exposure in deposits and FX settlement with data on unutilised collateral in RIX, the payment system. These calculations have been performed for the other major Swedish banks and for the largest FX settlement counterparty as reported by the banks. The full loss from a counterparty is related to the unused collateral in the payment system. If the loss is larger than the posted unused collateral, it is indicated in Table 1 below as a liquidity effect. The severity of the liquidity shortage varies considerably between the six cases.

Table 1

Liquidity effects on Swedish banks on 30 September 2001

Affected bank	Failing bank				
	Bank A	**Bank B**	**Bank C**	**Bank D**	**Largest FX counterparty**
Bank A	–				
Bank B		–			
Bank C		Liquidity effect	–		Liquidity effect
Bank D	Liquidity effect	Liquidity effect	Liquidity effect	–	Liquidity effect

Source: Sveriges Riksbank.

The results in Table 1 are only indicative of the possible liquidity effects, as the calculations are for one specific date. The calculations also do not take into account the fact that collateral in the Swedish payment system can be posted within minutes. The sale of other liquid assets by the bank could also mitigate liquidity effects. Another option is to borrow funds from other institutions, but in a situation where another Swedish bank has failed, this may be difficult since lenders may be reluctant to provide liquidity to a bank within the same system.

This very limited approach makes it hard to draw conclusions. However, to only take into account the collateral that is posted in the RIX system, which is readily available for immediate borrowing, is a very conservative approach. A very limited conclusion may be that it is a good sign that liquidity effects are not observed for all banks under this conservative approach.

4. Counterparty credit risk mitigation

Interbank credit exposures are often thought of as a necessary result of banking business, ie there is not much that can be done about these exposures by the banks. Especially in a concentrated banking system like the Swedish system, this is a common perception. In this section, the available methods for counterparty credit risk mitigation are briefly discussed, and it is shown that there are ways of diminishing counterparty credit exposures.

The most obvious credit risk mitigation technique is of course the setting of credit limits. There are substantial differences between the Swedish banks as regards the size of the exposures to counterparties they are willing to accept. This indicates that it is possible to set conservative credit limits, especially since these patterns are consistent over time in our data. In order to have conservative credit limits, it may be necessary to have an extensive network of counterparties, in order to diversify counterparty credit risk by using different counterparties, ie name diversification.

Swedish banks do not in general see FX settlement exposures as ordinary credit exposures. Before 1998, banks did not in general have any systems for limiting these exposures. Since then, the four largest Swedish banks have all introduced FX settlement limits. These limit systems are separate from the ordinary credit limit systems. It could be discussed whether these normal credit limits and FX settlement limits should be integrated, in order to have better control over total credit exposures within the bank.

The most important way of limiting FX settlement exposures is of course the introduction of a PVP mechanism for FX settlement. The creation of the CLS Bank is naturally a major step, which will decrease settlement exposures substantially. For the Swedish banks, however, the effect will not be that big initially, since the Swedish krona is not one of the original member currencies and a major part of Swedish banks' FX positions involve the krona (Figure 11).

As banks take on positions against each other on either side of the balance sheet, the scope for netting these exposures is important. Both positive and negative positions against the same counterparty could be netted, particularly in derivative positions. Master agreements[17] that allow for netting of derivative positions are commonly used by the Swedish banks and their most important counterparties in these markets. With respect to the positions reported to the Riksbank, netting reduces the credit positions by an average 55 to 60% for the 15 largest counterparties. It is more uncertain whether other kinds of exposures could be netted against each other in case of a failure.

Another obvious credit risk mitigation technique is the use of collateral. The most apparent area for this is financing, where banks can choose to lend to one another using uncollateralised deposits or collateralised transactions; in Sweden this is mainly done through repurchase agreements. Collateral is of course costly, and banks are not likely to always hold a sufficient amount of securities that can be used as collateral for all transactions. Another area where the use of collateral is growing is in derivatives trading. This applies especially to derivatives with long maturities, where posting collateral can be a very attractive way of hedging counterparty risk.[18]

5. Summary and policy conclusions

Sweden has a concentrated banking system, with four large banks covering at least 80% of the system, as in many other small countries. This is one reason to expect large interbank exposures within these systems, as banks may have few other alternatives than to deal with each other in the interbank markets. Data on interbank exposures shows that internal direct contagion effects are less than might have been expected in the Swedish banking system. In most cases where one of the four banks fails, the other banks will not suffer direct losses that would reduce their Tier 1 capital ratio below the regulatory level. However, this could occur on some occasions, according to the data set. Moreover, exposures are measured at the end of the quarter, so they are probably underestimated compared to exposures at peak levels, particularly intraday exposures. Therefore, a reduction of interbank exposures between the large Swedish banks is desirable in order to limit the risk of direct contagion within the Swedish system.

The risk of direct contagion from abroad mainly arises from foreign exchange settlement exposures. There are a number of cases where failure of a foreign counterparty causes one of the Swedish banks

[17] Master agreements in this context are derivatives contracts developed by industry organisations such as ISDA that allow for a standardised treatment of several derivatives deals between two counterparties, for instance regulating netting opportunities.

[18] For a discussion on the use of collateral and its implications, see CGFS (2001).

to be hit by a loss that makes its Tier 1 capital ratio decrease below the regulatory level. If FX settlement exposures are excluded, there are no cases where a Swedish bank will suffer a loss from abroad that leads to a Tier 1 capital ratio that is too low. The introduction of PVP mechanisms in foreign exchange settlement through the CLS Bank is a major advancement in risk reduction for banks active in the foreign exchange market.

Swedish banks show substantial differences with respect to the size of the individual exposures they are prepared to have to their counterparties. This indicates that it should be possible to reduce interbank exposures even in a concentrated banking system. It also leads to the conclusion that banks with large exposures in the interbank market are the ones we need to observe more closely.

The main ways to decrease the size of exposures between banks are to diversify exposures across more counterparties, to use collateralised instruments when possible, to adopt netting and to use clearing and settlement systems that provide for DVP or PVP when available. Many of the markets in which large exposures arise for the Swedish banks are international markets, where the concentrated national banking system does not pose an obstacle to diversification to a larger number of counterparties.

Swedish banks are universal banks that do not differ particularly from other large international banks. There is no reason to believe that banks in other countries differ substantially from Swedish banks with respect to exposure to direct contagion. The substantial differences with respect to the size of the largest exposures between Swedish banks suggest, however, that there may be significant differences in individual banks' exposure to direct contagion effects. One element that may lead to a larger exposure within the Swedish system compared to other countries is the substantial holdings of mortgage-backed bonds in Swedish banks. Most of the mortgage institutions are subsidiaries of the banks and are thus seen as part of the banks in the context of contagion.

The large Swedish banks have relatively high ratings and must in general be seen as rather risk conscious. The observation that banks take on exposures so large that they may not fulfil capital adequacy rules if there is a large loss on one of them suggests that the banks see sudden failure of an important counterparty as an extremely unlikely event. The reason is probably not merely the actual probability of the event occurring, but also expectations that the authorities would not allow sudden failure of an important bank. The fact that this kind of expectation exists is confirmed by the discussions that the Riksbank has had with the banks.

Moral hazard thus seems to be present with respect to exposure to direct contagion. As the fear of contagion is one of the most obvious reasons for public authorities to intervene, it is hard to see incentives for banks to decrease these exposures. To some extent, they are actually protected by the existence of risks of direct contagion, as these make government intervention more likely. Consequently, this can be seen as a market failure, which makes it reasonable to question whether there is scope for regulation in this area. In its FSSA for Sweden, the IMF stressed the importance of monitoring counterparty exposures, and suggested even more focus on these risks.[19]

In Sweden, the Riksbank has had discussions with the supervisory authority (FSA) on whether the rules on large exposures should be sharpened, in order to also take into account short-term interbank exposures. The conclusion has been not to do so at this stage. The reason is that the regulatory system is developed internationally, particularly within the European Union. The level playing field argument makes it difficult to suggest harder rules for national banks than are required by the EU system. It seems, therefore, more natural to bring up the issue in international discussions. However, the strong focus on Basel II, where these issues are not discussed, has made this quite difficult. Another reason not to introduce new rules at this stage is the creation of the CLS Bank. As quite a large portion of the contagion effects arises from FX settlement exposures, the total exposure to direct contagion might diminish substantially with the introduction of CLS. Instead of introducing stricter regulations, the Riksbank and the FSA will jointly increase the monitoring of banks' counterparty and settlement risk management, in particular the setting of credit limits. Monitoring credit limits can be an alternative to measuring actual exposures as the Riksbank currently does, especially since this may

[19] FSSA (Financial System Stability Assessment) is quite a new activity by the IMF, in which national financial systems are assessed on whether they subscribe to international standards and codes and whether the regulation and surveillance of the financial sector by the authorities are satisfactory.

be less burdensome for the banks involved and since the limits reveal the maximum exposure that the banks are willing to accept. On the other hand, individual limits reveal even more of the banks' business strategy than actual exposures, and banks may be even more reluctant to reveal this information.

Another way of improving counterparty exposure measurement would be to pick some of those counterparties that are commonly among the largest, and ask the banks to report their exposure on a day-to-day or even continuous basis. This would show whether there are high variations in exposures, and in particular whether exposures are underestimated in end-of-quarter reports, while at the same time not burdening the banks with the cumbersome work of ranking counterparties.

Another alternative to imposing stricter rules on large exposures is to consider whether it is possible to increase transparency in this area. If banks had to show their exposure to single counterparties in some form (of course without giving out the names of the counterparties), this ought to benefit the banks' investors, as it indicates the banks' ability to manage their risks. This information could be used to raise the required return on their investment or to drive down the size of exposures depending on the risk appetite of the investors.

To sum up, counterparty exposures and what they mean for systemic risk is an area where little work has been done. The Riksbank's measurement and analysis is a first step, as a means to understand the nature and the level of the problem in one particular banking system. However, more focus in the regulatory community and in the academic field would be warranted, since counterparty exposures are one of the major sources of systemic risk.

Appendix 1

	Counterparty	Derivatives	Securities	Deposits		Total	FX settlement	Stock loans	Repurchase agreements	Other collateralised loans	Exposures to companies within the same group
				Gross	Net						
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
Total											

	Counterparty	SEK/EUR	SEK/USD	EUR/USD	EUR/Other	SEK/Other	Other/Other	Total
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
Total 15								
Total								

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