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The role of macroeconomic shocks in banking crises

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Abstract

The macroeconomic reasons for the recent banking crises in the Nordic countries are analysed using an econometric model estimated with panel data from the 1980s and 1990s. Two alternative dependent variables are used: the ratio of banks' loan losses to lending and enterprise bankruptcies per capita. The explanatory variables are the lagged dependent variable, lagged percentage change in GDP, an income surprise variable combined with lagged aggregate indebtedness, a real interest rate surprise variable combined with lagged aggregate indebtedness, and a deregulation dummy. The innovation in this paper is the use of surprise variables based on macroeconomic forecasts.

According to the results, high indebtedness combined with negative macroeconomic surprises contributed to the recent banking crises in Sweden, Norway and Finland. Also the effects of the preceding financial liberalization and lending boom on bankruptcies and loan losses can be traced in the results. The econometric testing did not indicate direct effects of the exchange rate or the terms of trade on the banking crises.

Denmark did not suffer a banking crisis because the macroeconomic surprises were smaller there and the initial debt burden was lighter than in the other Nordic countries. This was the result of, among other things, earlier financial deregulation, which was conducted in a fairly balanced way, and a different economic policy regime, as Denmark belonged to the ERM.

Key words: financial deregulation, indebtedness, shock, loan loss, banking crisis

Makrotaloudelliset sokit pankkikriisin aiheuttajina

Suomen Pankin keskustelualoitteita 6/2001

Jarmo Pesola
Tutkimusosasto

Tiivistelmä

Tutkimuksessa on analysoitu pohjoismaisten pankkikriisien makrotaloudellisia syitä käyttämällä ekonometristä mallia, joka on estimoitu 1980- ja 1990-lukujen paneeliaineistolla. Selitettäviä muuttujia oli kaksi: vaihtoehtoisesti pankkien luottotappiot suhteessa antolainaukseen tai yritysten konkurssit suhteessa maan väkilukuun. Selittäjinä olivat viivästetty selitettävä muuttuja, viivästetty BKT:n kasvuvauhti, tuloyllätysmuuttuja yhdistettynä kokonaisvelkaantuneisuuteen, korkoyllätysmuuttuja yhdistettynä kokonaisvelkaantuneisuuteen sekä liberalisointidummy. Uutta tässä tutkimuksessa on se, että tässä käytetään makrotaloudellisiin ennusteisiin nojautuvaa yllätysmuuttujaa.

Tutkimustulosten mukaan negatiivinen makrotaloudellinen yllätys velkaantuneissa talouksissa selittää pankkikriisien syntyä Ruotsissa, Norjassa ja Suomessa. Tuloksista ovat myös nähtävissä rahoitusmarkkinoiden aiemman vapauttamisen ja luotonannon voimakkaan kasvun vaikutukset konkurssien ja luottotappioiden syntyyn. Ekonometrinen testaus ei sen sijaan antanut viitteitä valuuttakurssin tai vaihtosuhteen suorasta vaikutuksesta pankkikriisin syntyyn.

Tanska ei kärsinyt pankkikriisistä, koska makrotaloudelliset yllätykset ja velkaantuneisuus olivat siellä vähäisempiä kuin muissa Pohjoismaissa. Tämä johtuu mm. aikaisemmassa vaiheessa toteutetusta rahoitusmarkkinoiden vapauttamisesta, joka lisäksi sujui tasapainoisemmin kuin muissa maissa, sekä erilaisesta talouspolitiikkaregiimistä, joka puolestaan johtui Tanskan kuulumisesta ERMiin.

Asiasanat: rahoitussektorin liberalisointi, velkaantuneisuus, sokki, luottotappio, pankkikriisi

Contents

1 Introduction

Financial stability is important for sound economic growth. It is also a precondition for conducting effective economic policy. On the other hand, a stable and strong macroeconomic setting is one of the cornerstones of financial stability.

This mutual interdependence is generally acknowledged. The consequences of financial fragility have been demonstrated in connection with numerous banking crises throughout the world, including those of the Nordic countries in the last decade. The crises have prompted several worldwide empirical studies many of which have included often the Nordic countries. This study focuses on the latest financial liberalisation period and the subsequent crisis episodes in those countries.

Those nasty experiences have shown how important it is to fight financial fragility and to prevent severe financial crises from emerging. This is now also usually taken into account in the central banking legislation. For instance, the Act on the Bank of Finland requires the Bank to participate in maintaining the stability and reliability of the payment system and overall financial system. Furthermore, the central bank's responsibility for financial stability is often emphasized in Nordic central bank publications.[1]

The aim of this study is to analyse the reasons for the recent banking crises in the Nordic countries (excl. Iceland) by, among other things, building an econometric framework that clarifies the role of macroeconomic factors in causing the crises. The framework could be used with different risk scenarios so as to anticipate threats of banking sector stability or potential fragility that might demand preventive economic policy measures.

This study is the first attempt to analyse simultaneously the factors behind the Nordic banking crises and banking sector fragility using econometric methods. The analysis is done for the banking sectors in four Nordic countries: Denmark, Norway, Sweden and Finland, in the 1980s and 1990s. These countries are rather homogeneous small open economies where the banking sector holds a dominant position in financial intermediation; all of them liberalised the financial markets during the 1980s.

Three of the countries, viz Norway, Sweden and Finland, suffered from a severe banking crisis. Many banks faced insolvency, and official intervention was required to recapitalize the banking systems. Only three small banks were closed and their assets liquidated. Other problem banks were merged with or taken over by other banks.[2]

Limiting the study to the Nordic countries guarantees a relatively high quality of homogeneous data. For instance, it is possible to use loan loss and bankruptcy data, which allows for more nuances in the picture of banking stress than does the banking crisis dummy variable commonly used in other studies. Another novelty is the use of surprise variables to explain how the crises got started. This is an important part of explanation because virtually all economists failed to correctly

[1] See the survey done in connection with the Workshop for Non-Supervisory Central Banks in Norges Bank (the central bank of Norway), 6–7 June 2000: minutes of the workshop arranged by Norges Bank, 11 September 2000.

[2] Heikki Koskenkylä: The Nordic Countries' Banking Crises and the Lessons Learned, Bank of Finland, Financial Markets Department, Working Paper 6/00, 27 June 2000, p. 8.

forecast the economic recession in the early 1990s, which was particularly severe in Finland and Sweden.

The study might not give universally applicable results because of its regional limitation, but it should at least serve as a special case, and it is therefore of great interest to compare these results to studies on financial sector stability using a broader set of cases. Many such studies have recently been published, especially by the IMF.[3]

The structure of the paper is as follows. Section 2 presents some background facts on the Nordic banking crises, and some definitional matters are touched on. In section 3 the theoretical framework is set out. Our theoretical approach is anchored in a wide survey of the literature, with a resulting specification of a tentative behavioural model. The empirical analysis is presented in section 4. The econometric model for estimation is specified, the variables are presented and discussed, and the estimation results are presented and analysed. In section 5 the significance of the results is evaluated and some conclusions are drawn. In particular, it is shown that macroeconomic shocks, together with indebtedness, can explain the crises well.

2 Nordic banking crises: some basic features

At the outset, we distinguish between financial fragility and crisis. Bell and Pain (2000) make the following point. 'Fragility' can be viewed as relating to the structure of the financial system, and 'crisis' as a result of the interaction between that fragility and some exogenous shocks.[4] Keeping this distinction in mind could clarify the analysis that follows.

Loan losses were the main source of sharply negative banking profitability in the Nordic countries during the last crisis, as many and large credit risks were realized during the crisis.[5] The time series on loan losses can be considered as a suitable 'crisis indicator' in this study, and hence, it is chosen as the dependent variable for the econometric analysis. Beyond a certain point, the increase in loan losses point to a crisis. The problem is that it is very difficult to say in advance what that point will be.[6]

In 1991, one of the worst years of the Nordic crises, the ratio of operating profits to total assets of banks subject to official intervention was in Norway some –5%, in Finland nearly –3% and in Sweden over –10%, whereas the figure was virtually zero before loan losses.[7] Loan losses cumulated sharply in all of the Nordic Countries in the early 1990s, as can be seen from chart 1. This is generally

[3] Also the ECB is planning to start an EU-wide empirical research project on the stability of banking systems.

[4] The authors give a practical example. A crystal glass is fragile because of the structure of its molecules. There is however no problem (or crisis) unless the glass is struck by a sufficiently hard blow (shock). See, James Bell and Darren Pain: Leading indicator models of banking crises – a critical review, Financial Stability Review, Issue No. 9, Bank of England, December 2000, p. 124.

[5] See eg Koskenkylä (2000, p. 3) for all of the Nordic Countries and Jarmo Pesola: Macroindicators for Banking Sector Stability in Finland, Bank of Finland, Financial Markets Department, Working Paper 9/00, 31 August 2000, p 13–16 for the Finnish case.

[6] It is often not easy afterwards either, as we will see later in connection with the literature survey.

[7] Burkhard Drees and Ceyla Pazarbasioglu: The Nordic Banking Crises, Pitfalls in Financial Liberalization? IMF Occasional Paper no. 161, Washington DC, April 1998, p. 25.

deemed as a banking crisis in those countries.[8] The Finnish banks' cumulated loan losses during the five-year period 1991–1995 exceeded their regulatory capital as at the end of 1990.[9]

It was clearly shown in the Nordic banking crises that the fragility of banking sector closely reflects the financial soundness of its customers. Failures in the enterprise sector contributed crucially to the recent banking crises in Norway, Sweden and Finland. For example, some three-fourths of banks' loan losses were caused by bankruptcies in the corporate sector in Norway and Sweden.[10] The role of enterprise bankruptcies in generating loan losses can be easily observed from chart 1. Therefore, the main focus here is on the behaviour of firms. We must however not forget, in this connection, that households' share in bank lending,[11] and thus in credit risk, is also significant.

Customers' fragility depends importantly, in turn, on the state of the macroeconomic environment and certain microprudential factors, such as indebtedness and profitability. Macroprudential indicators are usually divided into aggregated microprudential indicators and macroeconomic indicators (see appendix 1, IMF categories of macroprudential indicators).

We try in this study to find empirically the macroeconomic shocks that triggered crises in the fragile financial systems. We will thus focus mainly on macroeconomic aspects of banking and will ignore such microprudential aspects, albeit important ones, as the degree of competition inside the financial sector, risks of contagion and so on.

Indebtedness is nevertheless a microprudential factor of great importance. It is clear that a heavily indebted enterprise or household is less able to weather a macroeconomic shock, than one with a lighter debt burden. The same thing holds at the aggregate level. For example, we can compare indebtedness at different time points in an economy or between economies. The likelihood of realized credit risks is greater when total indebtedness is high than when it is low. And, realized credit risks mean loan losses for banks. Hence, increased indebtedness is reflected as increased financial fragility.

The evolution of aggregate indebtedness in the Nordic countries can be seen in chart 2 where vigorous credit cycles are shown. Indebtedness, which generally was relatively low in the 1960s and 1970s, started to increase in the 1980s, though a bit earlier in Sweden. Domestic credit in relation to GDP reached some 90% in Finland and Sweden before it fell sharply. The changes in indebtedness were most dramatic in Finland and the smoothest in Denmark. The level of indebtedness has stayed clearly on a higher level than before the cycle, in all the Nordic countries.

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[8] See eg, Carl-Johan Lindgren, Gillian Garcia, and Matthew I. Saal: Bank Soundness and Macroeconomic Policy, International Monetary Fund, 1996, p. 20–35. According to the authors, the banking crisis years were:

1991–1994 in Finland
1987–1993 in Norway
1990–1993 in Sweden.

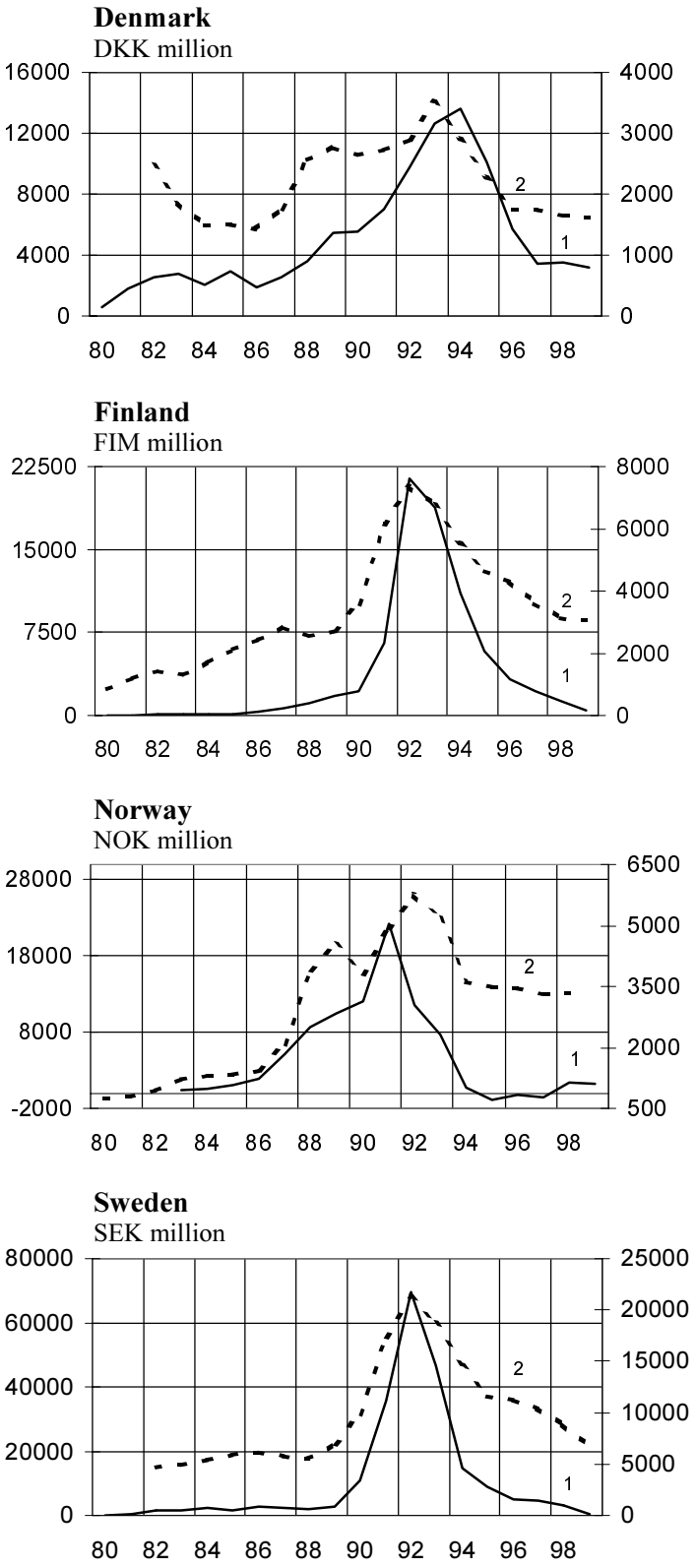
Denmark suffered from significant problems in banking sector in 1987–1992.

[9] Vesa Vihriälä: Banks and the Finnish Credit Cycle 1986–1995, Bank of Finland Studies E:7, 1997, p. 39.

[10] Drees-Pazarbasioglu (1998, p. 23 and 24).

[11] For example, in Finland households owe over half of banks' outstanding lending stock.

Chart 1. **Banks' loan losses, (millions) and number of enterprise bankruptcies**

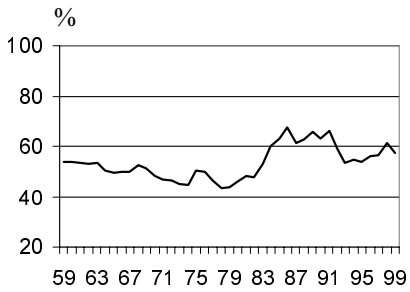


1 Loan losses (left scale)
2 Bankruptcies

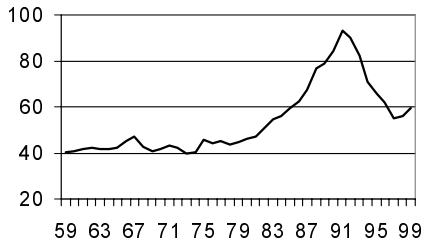
Source: Nordic central banks

Chart 2. **Aggregate indebtedness in the Nordic Countries, 1959–1999. Domestic credit / GDP, %**

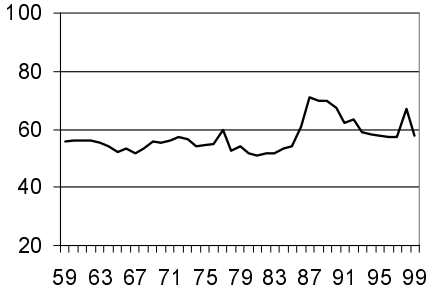
Denmark



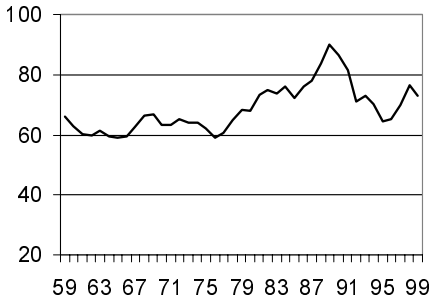
Finland



Norway



Sweden



Source: IFS

3 Financial fragility and economic shocks: a survey of theories and empirics

As pointed out above, the financial soundness of customers affects strongly on the fragility of banking sector. Even though a bank customer can be any economic entity in the public or private sector, the bulk of loan losses is caused by firms; only a fairly small part is caused by households, as we saw in section 2. The public sector instead generates virtually no loan losses. As it is also highly likely that the debt behaviour of the corporate sector and the rest of the private sector do not differ fundamentally much from each other, the behaviour of firms can represent that of the total private sector. Thus, we must look in the first place at the determinants of corporate sector soundness.

We adopt the so-called debt-deflation approach[12] in this study, as indebtedness is one of the most important factors in corporate soundness. According to the debt-deflation theory, a cumulative process of bankruptcies can be triggered when highly leveraged firms face a negative shock, eg a sharp deterioration in economic fundamentals. This affects firms' productivity or net wealth. The initial shock generates a decrease in investment and total demand and thus in prices. This aggravates the real indebtedness of the productive sector, which may provoke a further series of failures, causing loan losses to creditors and so on.[13]

The attempt to contract monetary liabilities, ie debt liquidation, can in the worst case generate and further amplify a vicious circle, where economic activity shrinks, leading to further attempts at debt liquidation. This may even result in a deep economic depression with a rapid accumulation of loan losses leading to a banking crisis.

Debt deflation theory starts from the fact of high indebtedness. But it is also necessary to determine the causes of increased financial fragility. This is the first question we attempt to answer. As we will see, it seems that financial liberalisation has a significant role in the Nordic countries in this respect.

[12] The idea of debt deflation was first presented by Irving Fisher in the 1930s. He presented originally the idea of debt deflation in his book Booms and Depressions (New York 1932) in Appendix I: Approximate Typical Chronology of the Nine Factors. He further elaborated his idea in Econometrica 1, October 1933 in the article 'The Debt-Deflation Theory of Great Depressions', where he presented a logical order of nine chief factors and their interrelations which can initially disturb the economic equilibrium and can further push the economy into a vicious contracting circle, p. 341–345.

Söderström in 1993 suggested that the debt-deflation approach is well suited to study of the Finnish economic depression. See Hans Tson Söderström: Finland's Economic Crisis: Causes, present nature, and policy options, in Bank of Finland's Publication, Three Assessments of Finland's Economic Crisis and Economic Policy, Bank of Finland C:9, 1993, p. 155–158.

[13] This interpretation of debt-deflation theory was given by Xavier Freixas and Jean-Charles Rochet in their textbook: Microeconomics of Banking, MIT 1997, p. 159.

3.1 Institutional and microeconomic background

3.1.1 Financial liberalisation, lending booms and indebtedness

Exceptionally rapid growth in bank lending can lead to a surge in loan losses later on. That result is implicated in studies done by Keeton (1999) and Gourinchas, Valdes and Landerretche (1999).[14] Also Schneider and Tornell (2000)[15] and Logan (2000)[16] have pointed to preceding lending booms as one of the causes of financial crises.

According to Keeton (1999), a surge in loan losses is highly probable, in particular, when lending growth is caused by a supply shift in lending – ie an increase in banks' willingness to lend. In that case banks tend to reduce the interest rate charged on new loans and to lower their minimum credit standards for new loans.[17] It is likely that this was the case in the Nordic countries in the run-up to the recent banking crises.

Financial liberalisation has often been a cause of lending booms. According to Gourinchas et al. (1999), a poorly regulated financial liberalisation in particular tends to end in a banking crisis. A lending boom is the natural outcome of liberalisation in a country that has had an overly regulated banking industry. The ratio of credit to GDP is usually considerably lower in strictly regulated countries than in countries with less repressed financial markets.[18] Eichengreen and Arteta (2000) get a similar result using a sample of emerging market economies. This suggests that a banking system is most at risk when financial deregulation and macroeconomic environment combine to create an unsustainable lending boom.[19] The financial sector was liberalised in all of the Nordic countries prior to the recent crises.

Drees and Pazarbasioglu (1998) summarize the main reasons for the banking crises in the Nordic Countries.[20] According to the authors, many banks felt compelled to expand their lending aggressively to secure their positions in the new deregulated environment. Those aggressive lending policies were accompanied by a noticeable increase in risk taking. The banks in Finland, Norway and Sweden faced deregulation relatively poorly capitalised, which made them vulnerable to loan losses in case of adverse economic shocks. This gave the

[14] See William R. Keeton: Does Faster Loan Growth Lead to Higher Loan Losses? Federal Reserve Bank of Kansas City: Economic Review, Second Quarter 1999, and Pierre-Olivier Gourinchas, Rodrigo Valdes and Oscar Landerretche: Lending Booms: Some Stylized Facts, mimeo, Princeton University, August 1999.

[15] Martin Schneider and Aaron Tornell: Balance sheet effects, bailout guarantees and financial crises, NBER Working Paper 8060, December 2000.

[16] Andrew Logan: The early small banks crisis: leading indicators, Financial Stability Review, Issue No. 9, Bank of England, December 2000, p. 144.

[17] In contrast, an increase in lending due to a shift in borrowers' demand for bank loans or productivity will not necessarily lead to increased loan losses, see Keeton (1999, p. 61–63).

[18] Gourinchas et al. (1999, p. 33). The authorities compared 80 cases of lending boom episodes in a sample of over 90 countries.

[19] Barry Eichengreen and Carlos Arteta: Banking Crises in Emerging Markets: Presumption and Evidence, Centre for International Development Economics Research Working paper 115, August 2000, Haas School of Business, University of California Berkeley, p. 29.

[20] Drees-Pazarbasioglu (1998).

banks a strong incentive for risk taking to maximize the option value of deposit insurance.[21]

The explicit deposit insurance system was however not large enough to cover the losses caused by an extensive systemic crisis. Hence, the obvious implicit government guarantee on banking might have increased further the risk taking incentive and moral hazard behaviour.[22] Also Schneider et al (2000) conclude that that systemic bailout guarantees, together with poor banking supervision, can generate boom-bust episodes.[23]

Also Davis (1995) points to increased competition for market shares after the long period of strict regulation, which induced Nordic banks to expand their lending strongly in the late 1980s.[24] Ongena, Smith and Michalsen (2000) note that financial liberalisation in Norway most likely accentuated the loan losses because of poor decision-making, high risk taking, and outright fraud in bank lending.[25]

Even though the economic depression and banking crisis were worst in Finland, the situation was by and large similar in the other Nordic countries, perhaps except for Denmark. The debt ratio was increasing rapidly, particularly in Finland in the early 1990s before the last deep depression and years of banking crisis.[26] As we can see in chart 2, the development was similar in all of the Nordic countries, albeit not always so drastic. The demand for loans grew rapidly because of the recent liberalisation of financial markets and an overheated economic situation.

There is evidence that the lowering of Finnish banks' credit standards allowed at least a part of the rapid increase in indebtedness. Several studies have found that one of the crucial reasons for the huge loan losses in 1992–1994 was banks' fierce competition for market shares, in which risk taking was to a large extent deliberate.[27]

The situation prevailing in the Nordic countries before the economic depression and banking crisis in the 1990s thus resembles the Keetonian case of supply shift in lending. The fact that banks' lending was based on unsustainable collateral values is alone sufficient to fill this condition. Koskenkylä (2000) points to the role of the bubble economy, which caused a huge increase in collateral values in the Nordic countries.[28] This raised collateral values to an unsustainable level.

The drastic fall in real estate prices during the economic depression is an indicator of the unsustainable price level prevailing prior to the banking crisis. For instance, in Finland, real estate prices were in 1994 some 25% of their peak level of 1989. In Norway the decrease was of the same size between 1987 and 1995. In

[21] Drees-Pazarbasioglu (1998, p. 15–21).
[22] See Vihriälä (1997, p. 129–134) for the Finnish case.
[23] See Schneider-Tornell (2000).
[24] See eg Davis: Debt, Financial Fragility and Systemic Risk, Oxford 1995, p. 256–259, 272–276 and 283–288.
[25] Steven Ongena, David C. Smith and Dag Michalsen: Firms and their distressed banks: Lessons from the Norwegian banking crisis (1988–1991), Board of Governors of the Federal Reserve System, International Finance Discussion papers, No 686, November 2000, p. 6.
[26] Pesola (2000, p. 21).
[27] See eg Vihriälä (1997, p. 130–133) and Nyberg-Vihriälä: The Finnish Banking Crisis and Its Handling, Bank of Finland Discussion Papers 7/94, 18 April 1994, p. 12.
[28] Koskenkylä (2000, p. 4).

Sweden real estate prices were in 1996 about 1/6 of their peak level of 1989.[29] Even if the banks did not know that there would be a deep recession, the lending expansion led to that result.

It might be worth while to note that the boom and bust development prior to the small banks' crisis in the UK in the first half of the 1990s was rather similar to that in the Nordic countries. According to Logan (2000) growth in output, credit and asset prices rose sharply, reaching a peak in 1988. Subsequently, as monetary policy was tightened, the real economy moved into recession, asset prices fell and the growth in credit declined sharply. This resulted in the failure of 25 banks.[30]

An interesting question in this context is: Why did Denmark not suffer from a banking crisis like the other Nordic countries during the observation period? Some tentative answers can be gleaned from the following facts. The deregulation started a bit earlier in Denmark than in the other Nordic countries (see appendix 2), and it was not as radical as in other Nordic countries. Further, the Danish banks were more used to operating in a competitive market than were the banks in the other Nordic countries.[31] Koskenkylä (2000) further points to the relatively strong solvency of the Danish banks.[32] That was the result of a tightening of solvency criteria in connection with liberalisation. According to Edey and Hviding (1995) an early introduction of prudential and disclosure rules appear to have led to earlier recognition of loan losses in Denmark.[33] For example, in Finland the respective tightening was delayed by several years.

Denmark also avoided the currency crisis that hit the neighbouring countries in the early 1990s. One of the important reasons for this might have been that the Danish krone was pegged in the Exchange Rate Mechanism (ERM) to the Deutschemark. Moreover, a relative moderate increase in indebtedness (chart 2) might have contributed to the resulting more favourable economic situation in Denmark.

3.1.2 The relevance of debt in microtheoretical models

One of the main results in debt-deflation theory is that the more indebted an economic agent, the more vulnerable it is to sudden unexpected adverse impacts, ie from negative surprises. Such a shock causes a negative balance sheet effect as it decreases the value of a firm, while the amount of debt remains intact. If a shock hits the whole corporate sector, the reaction, eg a drop in investment demand, can start a downward spiralling economic cycle.

As seen from the lenders' viewpoint, the negative economic shock increases credit risk as the value of firms' assets diminishes relative to its debt. The aggravated customer fragility causes an interest rate hike so as to compensate the increased credit risk, which further aggravates firms' profitability. This development can lead to a credit crunch in an extreme case if, eg creditors find that collateral values are limiting any further lending.

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[29] Drees-Pazarbasioglu (1998, p. 23).
[30] Logan (2000, p. 132).
[31] An unofficial analysis done at the central bank of Denmark, September 2000.
[32] Koskenkylä (2000, p. 11–12).
[33] Malcolm Edey and Ketil Hviding, OECD Economic Department Working Papers No 154, 1995, p. 55.

We refer below to some studies that conclude that indebtedness 1) constrains and 2) destabilizes economic activity. These can trigger a self-sustaining downward spiral, which might explain the rather drastic deterioration in the economic development that can be seen in connection with banking crises. The fact is that serious banking crises take place very seldom. For example, in Finland the most recent instance of growth in loan losses and bankruptcies prior to that in the 1990s occurred in the 1930s.[34]

Debt-deflation theory seems to conflict with the Modigliani-Miller (MM) theorem, which states that under certain rather strict conditions the corporate debt/equity ratio is irrelevant to the cost of capital.[35] Some authors interpret MM to implicitly imply the irrelevance of lenders' assessment of risk.[36] It nevertheless seems clear that highly indebted enterprises were the main agents behind the recent Nordic banking crisis and huge loan losses.

Restrictions in the MM theorem however limit its applicability. For example, costly bankruptcies mean that interest rates increase along with gearing because of the higher risk of loss in default. This aggravates profitability and increases the incentive to issue equity. This is, on the other hand, offset by tax deductibility of interest payments, which spurs debt issuance. In circumstances where, eg regulation keeps banks' lending rates artificially low, this, combined with the tax effect, can give firms an extra advantage in using debt financing. These examples suffice only to show that debt matters, contrary to the MM theorem.

The relevance of debt for the behaviour of economic agents has been demonstrated in several studies. For instance, Mervyn King (1994) developed further Fisher's idea of debt deflation.[37] King develops a theoretical model for household consumption with two types of agent: debtors and creditors.[38] Debtors consume less than creditors, due to precautionary saving. In King's multiple equilibria system, some points of equilibrium are unstable. Financial instability is possible, as even without any further demand shocks cyclical fluctuations can arise as the economy moves over time from one equilibrium to another.[39]

Kiyotaki and Moore (1997) have constructed a dynamic model where credit constraints on firms can generate an oscillating economy between certain floor and ceiling where recessions lead to booms which, in turn, lead back to

[34] See Pesola (2000, p. 13–15).

[35] A crucial assumption in the MM theorem is that the total amount of financing is given for a firm. Furthermore, MM's analysis excludes taxation and the possibility of costly bankruptcy and assumes perfect capital markets as well as symmetry of information and/or complete contracts between borrowers and lenders.

[36] See Davis (1995, p. 41).

[37] Actually, after Fisher's study in the 1930s the idea of debt deflation was practically dormant for several decades. In particular, when Franco Modigliani and Merton H. Miller in 1958 presented their view that the financial structure is irrelevant for the value of firm, the idea that finance would have any real impact was considered to be outdated for some time. According to Freixas and Rochet (1997, p. 160), the comeback of financial aspects in macro models started in the early 1980s.

[38] Mervyn King: Debt deflation: Theory and evidence, European Economic Review 38, 1994, p. 419–445.

[39] Compare with Diamond and Dybvig, who discuss the potential existence of multiple equilibria in financial markets. See Douglas W. Diamond and Philip H. Dybvig: Bank Runs, Deposit Insurance, and Liquidity, Journal of Political Economy, Vol. 91, June 1983, p. 401–419.

recessions.[40] With numerical simulations they estimate the length of a cycle to be about 10 years.[41]

There can also be problems arising from asymmetric information between lenders and borrowers. Lenders may not be able to verify the quality of borrowers, which can cause problems of adverse selection or moral hazard. In the case of adverse selection, an increase in the level of interest rates tends to lead to greater acceptance of risk among borrowers. For example, the composition of borrowers can change so that it includes more risk loving individuals, as the most risk averting individuals are no longer willing to borrow at the higher rates. Moral hazard behaviour tends to increase when borrowers believe that they can reap significant rewards if their investments are successful but lose little if they are unsuccessful.[42] Lenders require a higher return, ie a risk premium, to compensate for these risks and increased monitoring costs.[43]

For example, Hubbard (1997) analysed the dynamics between financing and investment when asymmetric information causes information costs and external financing is thus more costly than internal financing.[44] The larger the share of own resources, the lower the total average cost of capital, and the equilibrium size of the investment project varies respectively. Cyclical shifts in capital demand and supply feed the accelerator mechanism in aggregate investment, as the equilibrium amount of total investments varies.

In certain circumstances some enterprises are unable to obtain loans at any interest rate, as Stiglitz and Weiss (1981) have shown.[45] According to them, the loan market may be characterized by credit rationing, even in equilibrium. Namely, there may exist an optimal lending rate, beyond which the return to the bank falls despite excess demand for loans at that rate. If the interest rate were higher, increased defaults would more than offset any increase in profits. That kind of lenders' fear of adverse selection or moral hazard can generate a situation that resembles a credit crunch if, eg the equilibrium supply of loans contracts for some reason.

In sum, we can say that the microeconomic models inevitably demonstrate the importance of debt for the behaviour of economic agents. According to King's analysis, in which consumers are separated into debtors and creditors, debt has a potential destabilizing effect. Kiyotaki and Moore have shown that corporate sector debt can generate cycles in the economy. Both analyses conclude that debt places several kinds of constraints on those agents' possibilities to act. Hence, debtors' indebtedness is a crucial indicator of their fragility. Hubbard has shown that under imperfect information the cost of external financing can vary with the share of debt in enterprise financing. Thus, indebtedness tends to affect the interest rate that a firm faces. Moreover, the behavioural problems connected to

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[40] Nobuhiro Kiyotaki and John Moore: Credit Cycles, Journal of Political Economy, 1997 vol. 105, no. 2.

[41] Kiyotaki-Moore (1997, p. 238).

[42] Adverse selection is the problem created by asymmetric information before the transaction occurs, whereas the problem of moral hazard is created after the transaction. That is pointed out in Frederic Mishkin and Stanley Eakins: Financial Markets and Institutions, Reading MA, USA, 2000, p. 22–23.

[43] See for eg, R. Glenn Hubbard: Capital-Market Imperfections and Investment, NBER Working Paper 5996, April 1997, p. 3.

[44] Hubbard (1997, p. 4–8).

[45] Joseph E. Stiglitz and Andrew Weiss: Credit Rationing in Markets with Imperfect Information, The American Economic Review, June 1981, p. 393–409.

asymmetric information can outright give rise to increased loan losses. Stiglitz and Weiss rationalize credit rationing in certain situations.

3.2 Empirics of financial crises

After analysing potential institutional and microeconomic reasons for financial distress from a theoretical viewpoint, it is now time to look at some relevant macroeconomic factors that affect, in particular, small open economies. The approach below is mainly empirical.

3.2.1 External impact on small open economies

External circumstances are important for small open economies. This has been shown in the combined financial market and exchange rate crises, the so-called twin crises, in Latin America and recently in southeast Asia. External macroeconomic factors often contribute crucially to the development of twin crises, as indicated in many studies.[46] The Nordic countries experienced similar kinds of problems in the late 1980s and early 1990s.[47]

A typical boom-bust cycle would seem to proceed in the following way. During an initial lending boom, credit constraints are gradually relaxed as more internal funds become available and firms producing for the domestic markets increasingly incur debts also in foreign currency. In the Nordic countries, this development coincided particularly with financial liberalisation during the 1980s. In particular, rapid and full liberalisation can be harmful, as it can feed moral hazard and destabilize the economy if the prudential underpinnings of the banking system are not strong.[48] The real exchange rate appreciates during the boom, relieving firms' debt burden and encouraging further borrowing. Twin crises occur when a sharp real depreciation triggers widespread bankruptcies. Balance sheet effects, asset price deflation among them, lead to a collapse of investment demand in the nontradables sector, and the depreciation becomes self-fulfilling. The following crisis can be protracted, especially in the nontradables sector.

We must in this connection recall that the empirical observations in this study cover the period before the start of Economic and Monetary Union (EMU) on the 1 January 1999. The Nordic regime changed partly as Finland joined the EMU at the start. Consequently, Finland cannot be considered a small open economy anymore, nor can Denmark, due to its connection (albeit weaker) to the EMU through the ERM2.

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[46] See for eg Graciela L. Kaminsky and Carmen M. Reinhart: The Twin Crises: The Causes of Banking and Balance-of-Payments Problems; American Economic Review, June 1999, p. 473–500 and Schneider-Tornell (2000). See also: IMF Occasional Paper no. 192: Macroprudential Indicators of Financial System Soundness, Washington D.C., April 2000, p. 16.

[47] See eg Koskenkylä (2000, p. 5–6) and Lindhe: Makroindikatorer på kreditrisker vid företagsutlåning, Penning och valutapolitik 1/2000, Sveriges Riksbank, p. 76.

[48] See eg G. Corsetti, C. Pesenti and N. Roubini: Paper Tigers? A model of the Asian crisis, European Economic Review 43, 1999, p. 1225 and 1231, and Philippe Aghion, Philippe Bacchetta and Abhijit Banerjee: Capital Markets and the Instability of Open Economies, CEPR, DP 2083, p. 21 and 32. Note in this connection also the results of Gourinchas et al (1999) and Eichengreen et al (2000) in section 3.1.

Both the Mexican and Asian crises prompted a number of econometric studies on financial crises, as shown by a survey reported in a recent IMF Occasional Paper 192/2000.[49] After the Mexican crisis in 1994 these studies investigated the vulnerability of financial institutions in the face of exogenous shock, where highly leveraged financial intermediaries transact in markets with asymmetric information, subject to moral hazard generated eg by deposit insurance. Sources of financial fragility can include a falling growth rate, deterioration in the balance of payments, high inflation, volatile exchange rates, surges in stock market activity and prices, credit booms, weakening exports, and a deterioration in the terms of trade. In addition, some of these studies highlight nonquantifiable indicators, eg deficient banking supervision, inadequate instruments of monetary control, as well as inadequate standards and practices, eg perverse incentive structures.

The Asian crisis in 1997 provoked a new wave of financial sector studies, according to the IMF (2000) survey. These confirm that external macroeconomic shocks, asset price booms, and inappropriate monetary and exchange rate policies all result in financial pressure and contribute to crises in financial systems that are inherently fragile. The destabilizing effects of overshootings and feedback effects as well as the impacts of unexpected shocks, such as the rapid change in the yen-dollar exchange rate, have been studied. Also, the contagion of financial crises between countries has been the focus of several studies. The IMF (2000) survey concludes, among other things, that, except for the impact of third-party exchange rate changes on the domestic economy, these macroeconomic developments do not really offer additional early warning indicators of financial health.

Studies of aggregated microprudential indicators show, among other things, that foreign borrowing, particularly short-term liabilities denominated in foreign currency, has an important role in explaining of financial crises. It was also concluded in the IMF (2000) survey that the introduction of macroeconomic variables significantly improves the explanatory power of models based on microprudential indicators.

3.2.2 Banking crises studies using macroprudential variables

We now turn to some recent econometric studies on banking crises in order to find common features. Table 1 lists some of the most important macroeconomic, and also microprudential, explanatory variables used in these studies. A common feature of all the models is that the dependent variable is a dummy, which usually gets the value 1 in a crisis and 0 otherwise. The most important (statistically most significant) explanatory variables are marked with a capital X, and the others are indicated by a small letter x. The very general picture conveyed by the table is complemented by some comments below.

[49] See IMF (2000, p. 14–17).

Table 1. **Macroprudential indicators from selected studies on banking crises**

Studies by authors[1]	G-P-B	E-R	D-D	H-P	K
Year of publication	1997	1998	1998	1999	1999
Macroeconomic indicators					
Lending booms	X	x	x	x	x
Asset price booms				x	
External deficits		x		x	x
Aggregated growth rate	x	X	X	X	X
Terms of trade			x	X	x
Level of domestic interest rates	X		X	X	X
Exchange rate misalignments	X	X	x	X	X
Inflation	x		X	X	
Indebtedness		x	x		X
Surprise variables					
Aggregate microprudential indicators					
Foreign exchange exposure		x	X	X	X
Nonperforming loans	X				
Aggregate risk-based capital ratio	x				
Ratio of deposits to M2 (or GDP)	x			X	x
Stock exchange prices					X
Aggregate average returns	x				

[1]Gonzāles-Hermosillo, Pasarbasioğlu & Billings (G-P-B); Eichengreen & Rose (E-R); Demirgüc-Kunt & Detragiache (D-D), Hardy & Pasarbasioglu (H-P), Kaminsky (K).

Gonzales-Hermosillo, Pazarbasioglu and Billings (GPB) analysed the Mexican financial crisis, which began in 1994.[50] They applied a two-step logit model to panel data comprising quarterly observations on 31 commercial banks between 1991Q4 and 1995Q4. The empirical results suggest that bank-specific factors (applying the CAMEL[51] rating system) and banking sector variables explain the likelihood of bank failure, whereas macroeconomic variables largely determine the time to failure in the second step estimation. Among the banking sector variables, the ratio of total bank loans to GDP and the ratio of the banking sector's nonperforming loans to total loans were rather strongly positively associated with the likelihood of bank failure. The rise in the last mentioned also decreased the survival time. GBP tested different alternative proxies for macroeconomic variables. High real interest rates and depreciation of the exchange rate clearly imply a decrease in the survival time of a bank.

Eichengreen and Rose (ER) studied 39 banking crises using panel data for 105 developing countries.[52] A probit model is estimated on annual observations, covering the period 1975–1992. According to ER, their strongest finding is on the role of changes in global financial conditions, and specifically on that of rising industrial-country interest rates, in precipitating banking crises. Also the slowing of growth in OECD economies, as well as at home, was associated with banking problems in emerging markets. Furthermore, overvaluation of the real exchange rate was significantly associated with the incidence of banking crises.

Demirgüc-Kunt and Detragiache (DD) studied the determinants of the probability of a banking crisis in a multivariate logit model using annual panel data for 65 countries at maximum over the period 1980–1994.[53] There were 31 episodes of systemic banking crises identified out of 546 observations. The estimation results indicate that low GDP growth is associated with higher probability of a banking crisis. Furthermore, both the real interest rate and inflation are highly significant, as well as the ratio of M2 to reserves (external vulnerability).

Hardy and Pazarbasioglu (HP) estimate a multinomial logit model, using a panel data for 50 countries.[54] The estimation covers, in the most cases, at least 8 years but sometimes more. Estimations were done for the 1980s and 1990s. The dependent dummy variable takes the value two in periods when banking sector difficulties emerge, one in the preceding period, and zero otherwise. According to the estimation results, a rise in the inflation rate was one of the most reliable early indicators of impeding banking sector problems. Furthermore, GDP growth deceleration, credit to the private sector, change in gross foreign liabilities relative

[50] Brenda Gonzáles-Hermosillo, Ceyla Pazarbasioglu and Robert Billings: Determinants of Banking System Fragility: A Case Study of Mexico, IMF Staff Papers, Vol. 44, No. 3, September 1997.

[51] The aspects in the CAMEL approach are: Capital adequacy, Asset quality, Management, Earnings, Liquidity.

[52] Barry Eichengreen and Andrew K. Rose: Staying afloat when the wind shifts: External factors and emerging market banking crisis, NBER Working Paper No. 6370, January 1998.

[53] Asli Demirgüc-Kunt and Enrica Detragiache: The Determinants of Banking Crises in Developing and Developed Countries, IMF Staff Papers, Vol. 45, No. 1, March 1998.

[54] Daniel C. Hardy and Ceyla Pazarbasioglu: Determinants and Leading indicators of Banking Crises: Further Evidence, IMF Staff Papers, Vol. 46, No. 3, September/December 1999 and Daniel C. Hardy and Ceyla Pazarbasioglu: Leading Indicators of banking Crises: Was Asia Different? IMF Working Paper 1998, WP/98/91.

to GDP, and real exchange rates were significant in some of the different experiments.

Kaminsky (K) constructed composite leading indicators of currency and banking crises in a sample of 20 countries.[55] All of the countries suffered from currency and banking crises during the sample period from 1970 to 1995. K uses a crisis indicator that was constructed in one of her earlier publications.[56] It is interesting to note that K identifies a banking crisis even in Denmark in 1987. K has here further developed the early signals approach presented in the Kaminsky, Lizondo and Reinhart report 1998 (KLR; referred in the next section). The best single variables for signalling banking crises were the real exchange rate and stock prices. The real interest rate differential, world real interest rate, foreign debt, output growth slowdown, and domestic real interest rate provided slightly weaker signals.

In sum, in all of the cited econometric studies, the dependent variable, banking crisis, was defined in advance. The usual approach is just to define whether there exists a crisis at a certain point in time. This approach leaves an element of judgement in the crisis variable, which has generated many different views on the timing, and even existence of, a single banking crisis. Moreover, it is not possible, in this way to separate crises of different degrees of seriousness.[57] In principle, this kind of judgement should preferably be left to professionals, ie the economic policy decision-makers. The more or less artificial dependent variable is one of the fundamental weaknesses of this approach.

This approach, ie the dichotomy between having a crisis or not, leads to a bivariate dependent variable, which is usually a dummy variable that takes the value zero or one, and the usual estimating technique is the logit or probit method. These tend to be rather complicated and restrictive as excemplified by the DD model. Interpretation of the coefficients is not very straightforward either, in practice.

The use of a continuous variable for the crisis indicator, eg loan losses, would make the estimation task much simpler, in principle. The reason for not using such a simple approach is often obviously a lack of suitable data. Because of heterogeneity of worldwide data, it is impossible to find a single comparable variable for use as a reliable crisis indicator (eg loan losses or bankruptcies) in wide panel studies.

The complicated estimation technique might partly explain the choice of fairly simple explanatory variables in the models above. For instance, there are certain surprise variables, but they are just simple inflation or interest rate variables, or variants of these. Furthermore, non-linear or cross-term variables are lacking. It is astonishing that such a simple but crucial variable as the level of indebtedness is not widely applied.

The most commonly used (and generally highly significant) explanatory macroeconomic variable is the aggregate growth rate, which is included in all of the studies displayed in table 1. Also, the level of domestic interest rates and

[55] Kaminsky: Currency and Banking Crises: The Early Warnings of Distress, IMF Working Paper, WP/99/178, December 1999.

[56] Kaminsky uses the crises definitions designed in the paper she wrote together with Reinhart, viz Kaminsky-Reinhart: The Twin Crises: The Causes of Banking and Balance-of-Payment Problems, Board of Governors of the Federal Reserve System International Finance Discussion papers, Number 544, March 1996.

[57] The few attempts done, eg Kaminsky, seem unconvincing.

exchange rate misalignments are rather commonly used indicators, as well as lending booms. The last mentioned variable has however not been very successful in estimation.

3.2.3 Predicting financial crises

Predicting ability is a strong test for a model's validity and usefulness. According to the authorities quoted in the previous section, their models perform quite well in their most important task – predicting crises. However, as noted above, the IMF Occasional Paper 192/2000 reflected scepticism regarding the early warning capability of macroprudential indicators.

Berg and Pattillo (1999) tested the predicting ability of three models that have been used to predict currency and twin crises.[58] Although those models unfortunately do not belong to the group analysed in the previous section, it is useful to consider Berg and Pattillo's study here. The models represent three different approaches for explaining and anticipating currency/banking crises, and they resemble the analysed models well enough to draw some reliable analogies.

Consider first the signal approach, as represented by the Kaminsky, Lizondo and Reinhart model (KLR; compare to the later K model discussed above).[59] They monitor a large set of monthly indicators that signal a crisis whenever they cross a certain threshold. Thus the crisis indicators are bivariate, in that each indicator is analysed and optimal thresholds are calculated, separately. The most informative indicators, according to Berg and Pattillo (1999), seem to be trend deviations of the real exchange rate, growth in M2, export growth, change in international reserves, 'excess' M1 balances, growth in domestic credit, the real interest rate and the terms of trade.

The second example is Frankel and Rose's probit model (FR), which is an earlier (and similar) version of the above-referred ER model. The crisis measure estimated with the FR model is binary: crisis or no crisis. Consequently, a currency crash is defined as a large depreciation (at least 25%) of the nominal exchange rate that also exceeds the previous year's change substantially (by at least 10%). Frankel and Rose use a panel of annual data for over 100 developing countries. According to the results, the probability of currency crisis increases when foreign interest rates are high, domestic credit growth is high, the real exchange rate is overvalued, and the current account deficit and the fiscal surplus are large.

A common special feature also in these two approaches is that the crisis must be defined before estimation, which always leaves room for judgmental elements in the basic analysis. In contrast, the Berg-Pattillo's (1999) third example (below) avoids this flaw by using a continuous dependent variable. Here the data deals with the problem.

Berg-Pattillo's (1999) third example is the cross section analysis of the impacts of the Mexican tequila crisis studied by Sachs, Tornell and Velasco

[58] Andrew Berg and Catherine Pattillo: Are Currency Crises Predictable? A Test, IMF Staff Papers, Vol. 46, No. 2, June 1999.
[59] Graciela Kaminsky, Saul Lizondo and Carmen Reinhart: Leading Indicators of Currency Crises, IMF Staff Papers, Vol. 45, No. 1, March 1998.

(STV).[60] They examine the determinants of the magnitude of the currency crisis in 20 countries in 1995. A crisis index is constructed as a weighted sum of the percentage decrease in reserves and percentage depreciation of the exchange rate. The dependent variable is a continuous time series in contrast to the two other cases, which used binary variables. The crisis index is regressed on variables representing the lending boom, exchange rate overvaluation and low reserves, in a partly nonlinear model.

Berg and Pattillo (1999) test the three models via out-of-sample prediction of the 1997 Asian crisis. The results of this test were not very encouraging. According to Berg and Pattillo, the STV and FR models did not perform better than guesswork. Only the KLR forecasts were clearly better than a naive benchmark of pure guesswork. But even the KLR model issued more false alarms than accurate warnings and missed most of the crises.

Bustelo (2000) reflects similar findings.[61] He studied the forecasting ability of models from nine empirical studies on financial crises. Six of these studies have been referred to above. He tests the models' ability to predict the Asian crises and comes to the conclusion that the crises differ importantly from each other and hence trying predict them on the basis of past developments is doomed to failure.

According to Bustelo (2000), because crises are unpredictable, specialists should refrain from creating and developing predictors and focus instead on simpler early warning indicators. Such indicators could reflect eg external vulnerability (eg short-term foreign debt/foreign reserves), domestic financial fragility following financial liberalization, or the process of declining investment efficiency.

Bell and Pain (2000) also conclude that leading indicator models for banking crises are of only limited value to policymakers. They reviewed some recent models that attempt to predict banking crises and find that in a number of cases the explanatory variables are only correlated contemporaneously with the crisis.[62]

It must to be acknowledged that these results do not bode well for further attempts to design models for anticipating future crises. This is particularly disconcerting, as the approach adopted in this study resembles most the approach of the STV model. But even the mere learning from past mistakes could help in preventing the re-emergence of similar accidents. Furthermore, an enhanced general alertness also helps in preventing and handling unanticipated crises that emerge in other forms.

In this study an attempt is made to correct some of these defects. Among other things, we use a continuous dependent variable, and the question of whether there was a crisis or not in a particular year can be left to be dealt with after the estimation results are presented.

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[60] Jeffrey D. Sachs, Aaron Tornell and Andrés Velasco: Financial Crises in Emerging Markets: The Lessons from 1995, Brookings Paper on Economic Activity, 1:1996.

[61] Pablo Bustelo: Novelties of financial crises in the 1990s and the search for new indicators, Emerging Markets Review, Vol. 1, No. 3, November 2000.

[62] Bell and Pain (2000, p. 126.)

3.3 Concluding framework for a crisis model: joint effect of financial fragility and economic shocks

Based on the above literature survey, we are to map out a sequenced macro-level development towards a banking distress situation.[63] We use a macroeconomic approach and abstract from (almost all) microprudential aspects. The bank customer is the starting point. The chain of events is based on interactive behaviour between banks an their customers. The customers consist of firms and households, albeit the firms are far more risky than the households.

At the outset, economic boom brightens customers' outlook. Their profits will increase, asset prices inflate etc. Expansion of macroeconomic demand leads to lending growth. If the outstanding loan stock grows faster than assets, indebtedness increases. The effect on the demand for loans is enhanced if financial liberalisation takes place at the same time. This could generate strong demand for bank loans, due to a stock adjustment in expected equilibrium-level indebtedness. A part of the borrowing, in this context can be denominated in foreign currency, which brings in the element of exchange rate risk.

Financial fragility tends to deteriorate particularly if banks' credit standards are relaxed. Unnoticed problems of asymmetric information tend to increase the fragility, in particular, if they worsen the borrower quality.

A macroeconomic shock, eg a deterioration in the terms of trade, an export slump, or a tightening of economic policy can set off a vicious circle leading to a banking crisis. This reduces the profitability of banks' customers. Weakened expectations can trigger an asset price fall that depresses collateral values. At the same time, an accumulation of nonperforming assets is initiated – an early warning sign. In the next phase, the number of bankruptcies increases, causing an increase in banks' loan losses. Loan losses are generated both directly, as a product of firms' bankruptcies, and indirectly as the deteriorating economic situation raises unemployment and hence reduces households' incomes and asset values and weakens their ability to repay debts.

Consequently, banks' profitability and solidity deteriorate and a distress situation may be in the offing. Banks' lending policy is tightened, which in turn has a negative feedback effect on the economy. In the worst case, a cumulative economic shrinking process can be put in motion.

According to this story, loan losses start to cumulate when a shock hits a fragile system. Hence a banking crisis, denoted by a crisis indicator, CI, is the product of a joint cause: fragility, F, and economic shock, S:

$$CI = F \cdot S$$

Both are necessary factors in generating a crisis. Sufficiency, in turn, depends on the combined effect of those two factors. For example, in a very fragile system, a fairly weak shock is sufficient to trigger a crisis. Table 2 gives a simple matrix presentation of crisis probability in different states.

[63] See also: Pesola (2000, p. 12–19).

Table 2. **Crisis probability**

Shock / Fragility	weak	severe
low	**unlikely**	**possible**
high	**possible**	**likely**

Financial fragility can be proxied at the macro level as the ratio between banks' outstanding debt D and total assets (wealth) in the economy, W:

$$F = \frac{D}{W}$$

Economic shock is the difference between W and its expected value, W^e:

$$S = W - W^e$$

W^e consists of current assets and the expected present value (PV) of their current and future income flows. PV of W^e changes when the economic outlook changes.

Let us drop to the single-firm level in order to analyse the nature and effects of economic shocks. Both the bank and the firm agree on a certain 'optimal' level of indebtedness for the firm when the loan contract is signed. They expect a certain future development starting from today's facts. One of the known facts is the firm's indebtedness as at yesterday, d(–1)/w(–1).

An unexpected event, the surprise, $w - w^e$, can come through a change in any of several variables: amount of sales, prices of products, level of costs and/or interest rate. A surprise is an actual outcome that differs from the expected one. For instance, if a firm yesterday expected to sell 100 units today, w^e, but the actual outcome today is 50 units, w, the firm is suffering from a negative surprise of –50 (= 50–100) units. This result immediately affects the firm's assets negatively and hence its net worth, as the debt is given. An unexpected interest rate increase is another possible negative surprise, as it would reduce profitability as well as the value of w.

Furthermore, the change in market value of the firm's property, w, also affects its borrowing capacity, as it can be used as loan collateral. The more indebted the firm, the smaller the negative surprise needed to cause a bankruptcy. According to Mishkin (2000) the negative net worth effect can also promote financial instability by worsening the problems of asymmetric information.[64]

A firm is declared bankrupt when its assets are smaller than its debt, $w < d$. The firm's net worth becomes negative. A debtless firm cannot go bankrupt. In the case of bankruptcy, the amount of bank's loan loss is max [d–w, 0].

Regarding households, the story is similar except for the bankruptcy, as personal bankruptcy is not possible under Nordic countries' legislation. Yet, the consequences of debt overhang can be even worse for a single person than for a

[64] Frederic S. Mishkin: Financial Stability and the Macroeconomic, Central Bank of Iceland, Working Papers No. 9, May 2000, p. 7.

firm. A firm can get rid of its debts by bankruptcy, whereas a private person cannot.[65] But the creditor acknowledges a loan loss at the moment of default also in the case of a private person.

On the macroeconomic level, the economic outlook affects the income flow expectations and thus the expected PV of aggregated private sector asset value:

$$W^e = f_a(X_i^e)$$

where i = 1, …, n.

The amount of expected factors X_i^e denotes the relevant factors forming the expected asset value.

The crisis indicator is mainly approximated by the amount of loan losses, LL, as mentioned earlier. Loan losses are generated in the 'mass' of loan stock, so they are some fraction of outstanding loan stock if lending risks are smoothly distributed according to some probability distribution. Therefore, we adopt loan losses in relation to outstanding loan stock as the left-hand side variable and denote

$$CI = f_b\left(\frac{LL}{D}\right)$$

In sum, loan losses divided by lending stock are generated as a function of the relevant factors as follows:

$$\frac{LL}{D} = f\left(\frac{D_{-1}}{W_{-1}} \cdot (W - f_a(X_i^e))\right)$$

Where the current macroeconomic state of affairs and outlook affects, $f(X_i^e)$ the PV of private sector assets and income, W^e. For example, it includes certain expectations concerning future developments in macroeconomic indicators such as GDP volume, prices or costs, interest rate, exchange rate or terms of trade. The further formulation of that behaviour must be left to the econometric analysis.

[65] For example, if a person cannot repay his loan, the creditor can sell the collateral (as in the firm bankruptcy case). But unlike the in firm case, where the event is over after bankruptcy, a person will still owe the creditor, if the selling price of collateral does not match the unpaid debt.

4 Empirical analysis of the Nordic banking crises

There are three aspects that limit the focus of empirical analysis to the two latest decades, namely the policy environment and the data. The financial policy regime changed in the 1980s. The earlier period was characterized by strict financial regulation in all of the Nordic countries.[66] Some of the most important measures and features of the regime shift are presented in appendix 2. The regime shift is reflected, among other things, in the level of indebtedness (chart 2) and in the number of bankruptcies in the Nordic counties (see chart A3.1 in appendix 3), which started to increase in the early 1980s.

The second limitation is that comparable banking data cannot be found for the years before the 1980s. This in particular concerns loan loss data, which comprise one of the main indicators of banking distress. Hence the annual data used in the econometric analysis start from 1983.

A further limitation for the explanatory variables is that the data would need to be common and timely updated in the statistics for every country. They also should be uniformly forecasted by macro forecasters so as to enable use of the results for prediction purposes.

Consequently, statistical data for the 1980s and 1990s in the four Nordic countries, Denmark, Norway, Sweden and Finland, is used in the empirical analysis. Econometric estimation is done using annual data and panel estimation. The estimation period is 1983–1998.

4.1 Causality hypotheses and model specification

According to the framework derived from the literature (section 3.3), a banks' credit risks will be realised because of the joint effect of financial fragility and economic shocks. Realized credit risks cause loan losses to banks as firms go bankrupt and households become unable to repay their debts. Consequently, the study focuses on two alternative dependent variables: loan losses (per total lending) and number of bankruptcies (per capita).

Regarding the explanatory variables, fragility was proxied by lagged aggregate indebtedness, D/W, representing both the corporate and household sectors. It is assumed that indebtedness affects positively loan losses and bankruptcies, eg an increase in indebtedness raises the amount of loan losses and bankruptcies. We assume below that the sign of causation is the same for loan losses and bankruptcies, and hence omit mentioning bankruptcies every time.

The plans of economic agents are based on the current state of affairs, the economic outlook and expectations and is denoted $W^e = f(X_i^e)$ in section 3.3. We start from the assumption that the basis for agents' expectations is the outlook for GDP growth, which represents generally the expected flow of income. This in turn affects investment and borrowing plans, ie future indebtedness. Instead of deriving theoretically the function for expected GDP, we use the OECD forecasts for the Nordic countries on percentage changes in GDP volume and GDP deflator.

[66] See eg Davis (1995, p 256, 257 and 284) as well as Koskenkylä (2000, p. 5 and 6).

Normally, the outlook for GDP should not affect the ratio of loan losses to lending stock. However, we saw in section 3.1.1 that, during periods of strong growth, relaxed loan standards can generate lending booms that end up in increased loan losses. It is possible that mere expectations of exceptionally vigorous growth can initiate such a lending boom, where the problems of asymmetric information become significant. Even borrowers who have no intention to repay can get loans in certain cases, as banks' project screening resources become stretched. In those cases no surprises are needed to generate loan losses. Hence, either GDP forecasts or the lagged GDP variable are used to capture the exceptional lending boom effect.

Expectations, in any case, are a very important factor in the shock variable, $W-W^e$. Unexpected impacts, macroeconomic shocks, lead to divergence between outcome and expectations. Although economic agents may try to react by changing their actions and plans, the effect of a shock can be seen in the number of bankruptcies and in loan losses. It is assumed that a positive shock or surprise in GDP volume decreases the amount of loan losses and vice versa. However, the effect of a GDP deflator surprise can be ambiguous ex ante, as we will see later.

Interest rates, exchange rates and terms of trade are other relevant variables for formation of expectations that are mentioned in the literature. The difficulty is that usually there are no regularly published predictions of these variables by the OECD or any other public body. However, assuming they behave as random walks, we can state that the static expectations are rational and accordingly any change in their value is surprising. On these grounds, we assume that an increase in interest rates, a devaluation of a country's currency or a deterioration in its terms of trade will tend to increase loan losses.

The static expectations for both interest and exchange rates can also be motivated by a period of regulation. Interest rates were very rigid during regulation and exchange rates were typically pegged to currency baskets. There is usually some inertia in changing the way in which expectations are formed. Actually, the currencies of Finland, Sweden and Norway were pegged to the ECU until 1992 when the countries adopted floating exchange rate regimes.

In a severe economic recession certain dynamics may start to work. A vicious circle can emerge, in which bankruptcies and loan losses generate new bankruptcies and so on until a banking crisis.[67] A lagged dependent variable can capture some of the feedback creating involved in such a vicious circle. A positive relationship is assumed between the dependent variable and its lagged value.

A regime shift caused by financial markets deregulation, which took place in the Nordic countries during the 1980s, was taken into account by adding a dummy variable for each country. It is assumed that there is a smaller amount of loan losses during the time of strict regulation than otherwise. The country-specific values of the dummy variables will be defined later.

Based on the above discussion, the basic model for estimation of loan losses is as follows:

[67] See Annemarie Van der Zwet and Job Swank: Financial Fragility and Macroeconomic Performance, A Comparison of Emerging and Highly Developed Countries, DNB (De Nederlandsche Bank) Staff Reports 2000, No. 52. The authors find cases where financial fragility affects macroeconomic performance.

$$LTL = a + bLTL_{-1} + cY^e + dYS \cdot \frac{D_{-1}}{W_{-1}} + eRS \cdot \frac{D_{-1}}{W_{-1}} + fES \cdot \frac{D_{-1}}{W_{-1}} + gDR + u$$

where:

$LTL = \frac{LL}{D}$ = loan losses per banks' outstanding lending stock
Y^e = expected income growth ie expected (or lagged) GDP growth
$YS = Y - Y^e$ = income surprise (Y = actual GDP growth)
RS = change in interest rate
ES = change in exchange rates (alternatively terms of trades)
D = total debt
W = total assets
DR = deregulation dummy
a … g = coefficients ie the parameters to be estimated
u = residual

The model structure is similar when using bankruptcies per capita, BRP, as dependent variable.

All the coefficients should receive the positive sign, except for d (the coefficient of income surprise variable multiplied by indebtedness) and f (the coefficient of variable ES multiplied by indebtedness), which should get a negative sign in the econometric estimation. However, there are some ambiguousness that will be discussed below.

4.2 Variables

The variables in the empirical analysis are annual macroeconomic or aggregated microprudential observations starting from the early 1980s. The data sources are the central banks and statistical authorities of the Nordic countries, as well as the IMF and the OECD.

4.2.1 Dependent variables: loan losses and bankruptcies

We observed above the close connections between the two alternative dependent variables, bankruptcies and banks' loan losses (chart 1). An intuitively natural causality runs from firm bankruptcies to banks' loan losses. Yet, while the Granger causality test points to causality for Denmark and Finland, the case is less clear for Norway and Sweden (table A3.1). Furthermore, the correlation between loan losses and bankruptcies is rather low in Norway, 0.6, while it is at least 0.8 for the other countries (table A3.2).

The reason for the difference might be the change in the loan loss provisioning rule in Norway in 1991, which made the provisions jump the next year (chart A3.2).[68] The Banking, Insurance and Securities Commission then

[68] One should also bear in mind the different contents of those time series.

introduced a distinction between specific and nonspecific loss provisions.[69] The losses might have been 'hidden' in the specific provisions.

In Finland also the provisions for loan losses in banks' balance sheets seem to move interestingly before the banking crisis. The amount of provisions fall sharply a couple of years before the explosion of loan losses in 1992 (chart A3.2). The amount of provisions seems to return quickly to the pre-crisis level in the latter half of 1990s.

A word of warning is needed here. If banks can manipulate rather freely between shares of loan losses and provisions in the balance sheets, the statistical reliability of actual loan losses might not be very high. The problem is the worse, the more time disaggregated the time series, because it is easier to manipulate the bookkeeping eg between months than between years.[70] The reliability can be checked to some extent by comparing loan losses to bankruptcies.

A comparison between value of loan losses and value of bankrupt firms' debt shows that banks were the primary holders of such debt during the worst years of the Finnish banking crisis (chart A3.3). Before and after the years 1992 and 1993 this was not the case. For instance, tax collectors and insurance companies have recently held the bulk of this debt.

The total amount of bankrupt firms' net worth in Finland seems to be less than the amount of loan losses between 1991 and 1994 (chart A3.3). At first sight, this might seem strange, but two factors could explain it. First, not all loan losses are caused by firm bankruptcies. There are also private persons, estate owners etc, who cannot repay debts. Second, every bankruptcy case is separate and cannot be 'pooled'. This means that there are cases were no part of the debt can be covered because the firm is totally devoid of property.

Moreover, the debt data do not cover all of the Finnish bankruptcy cases because they reflect only the debts of firms that are judged bankrupt by a court of law, and often there is no court case due to a lack of property to be realized. It has been estimated that only a third of the firms initially declared bankrupt are ultimately judged bankrupt by a court of law. The trials also take time – at least half a year – so that judged bankruptcies always lag behind declared ones, as can be seen in chart A3.3.

Even though the number of bankruptcies is expressed in a different dimension than the value of loan losses, its timing, in a macroeconomic sense, looks more reliable and exact than the bankruptcy debt data. Hence, the number of bankruptcies could serve as a kind of 'control variable' for loan losses in econometric estimation.

The different size of countries tends to cause extra variation in the cross section dimension of panel data. For example, it is clear that the number of bankruptcies tends to be larger in a country such as Sweden, which is circa two times bigger than another country such as Norway. This effect can be reduced if

[69] Report by the Commission on the banking Crisis, Norwegian Official Reports, Nor 1992: 30E, p. 20 and 21.
[70] See Pesola (2000, p. 16–19) for the Finnish case.

the number of bankruptcies is divided by the population in every country. Hence, the dependent variable is number of bankruptcies/population.[71]

Similarly, as we noted in section 3.3, it is quite natural to divide banks' loan losses by their outstanding lending stock, which is the 'mass' wherein loan losses are generated. At the same time, a relative variable lessens the cross section problem of panel data described above. Furthermore, being a monetary variable, loan losses also tend to follow the trends in economic growth and inflation, which can distort the econometric analysis. Hence, there are also econometric reasons for choosing banks' loan losses divided by lending stock as the dependent variable.

Loan losses divided by lending is shown country by country in chart 3, and bankruptcies divided by population in chart 4. Swedish data shows the highest peaks in both cases, while Denmark seems to have been hit the least by the economic recession in the early 1990s. Norway faced the problems earlier than the others, as it entered a prolonged recession in 1987, after the sharp fall in oil prices.

Chart 3. **Banks' loan losses/lending**

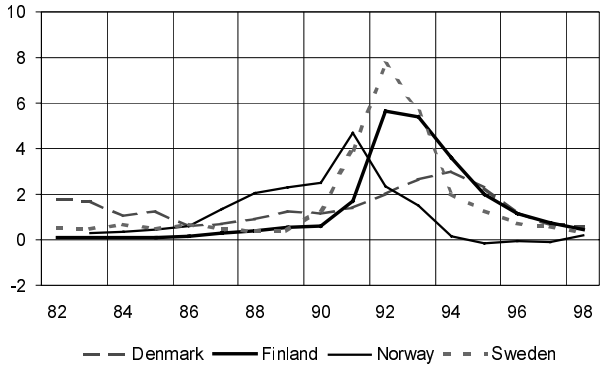
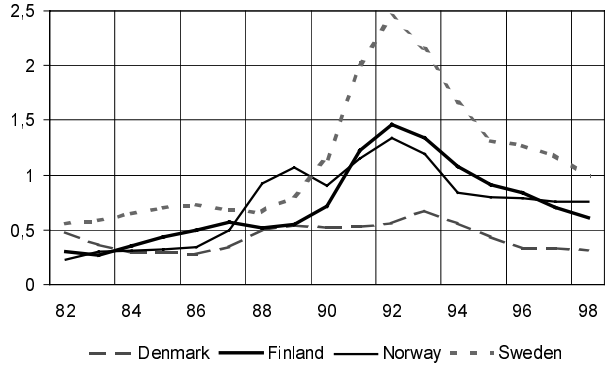


Chart 4. **Enterprise bankruptcies/population**



[71] In a growing economy also the number of firms tends to grow. That can generate a problem of multicollinearity when it is probable that that growth also adds the number of firm bankruptcies. This problem can be avoided by using a scale variable as population in this case. The probelm might nevertheless not be serious in rather short time spans like here as the in the number of firms probably is not growing very fast. A part of that development is reflected in the growth of the firms themselves.

4.2.2 Independent variables

As stated in section 3.3, the most important explanatory variables are the indebtedness and surprise variables. In this section we seek the most suitable country specific time series proxies for these variables.

A. Fragility variable: indebtedness

Banks' domestic credit divided by nominal GDP, ie total indebtedness, is the proxy variable for financial fragility (chart 2 in text). The statistical source is the IMF's International Financial Statistics (IFS).

For this study, the preferred numerator variable for the indebtedness proxy would be banks' lending to private sector, which is closer to the relevant agents. However, this is not available for Finland in the IFS.[72] The overall indebtedness picture does not differ much between those two proxies, as can be seen by comparing the charts 2 and A3.4. Furthermore, the estimation results did not significantly differ as between these two variables. Hence, for the statistical reasons, the indebtedness variable with domestic credit was chosen for the econometric analysis.

Nominal GDP is a proxy for total wealth in the denominator. GDP was chosen because of a lack of other reliable and suitable wealth indicators that could match total domestic credit in the numerator.

As can be seen from chart 2, macro-level indebtedness increased rapidly in every country in the latter half of the 1980s. This accords with the corresponding picture for inflation surprises (chart 7), which points to economic overheating. Indebtedness increased the most in Finland, where it started from a level of about 45% of GDP in 1982 and peaked at over 90% in 1992. In Sweden the peak was almost as high as in Finland, but the development started from a higher level, at about 70% of GDP in the early 1980s. In Norway and Denmark the development was less drastic. After the eruption of the banking crisis, indebtedness decreased rapidly even in Denmark, but it has generally stayed on a higher level than before the crisis.

B. The basic surprise variables

A surprise variable is a time series that consists of an estimate of expectations and an actual outcome. The economic surprise is the difference between them. For the expectations part, the OECD forecasts could represent common and universal

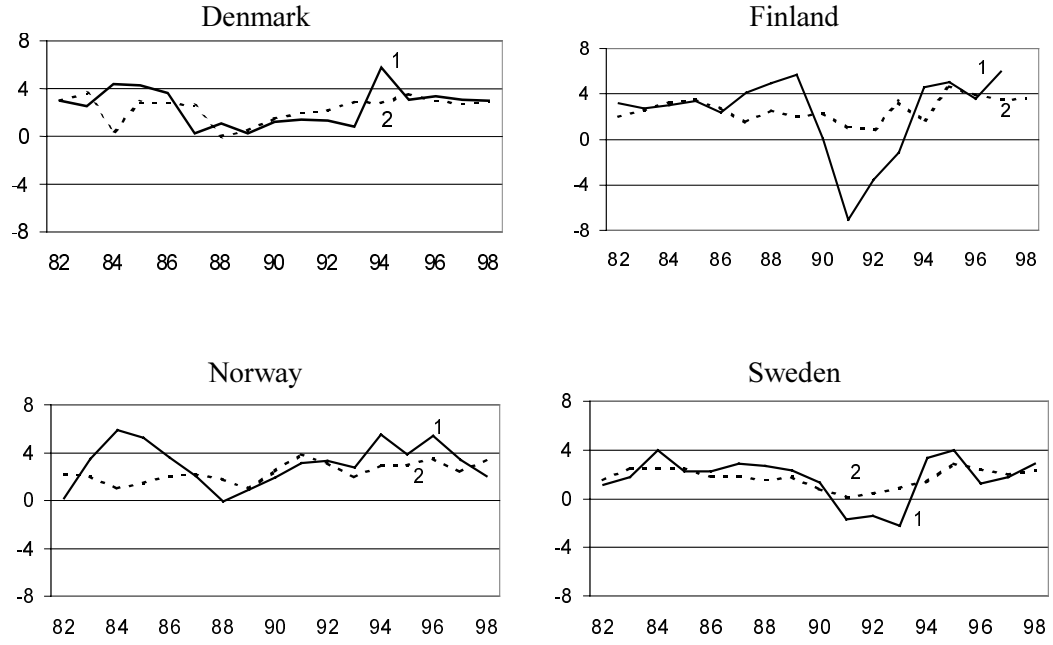
[72] Banks' stock of lending to private sector 'banks' claims on private sector' can be found outright for Denmark, Norway and Sweden. For Finland the item has to be constructed indirectly by subtracting the item 'claims on general government (net)'. The banks' net position vis-à-vis general government is about zero in Finland, while it varies rather much in the other countries. The gross position cannot be determined exactly from the statistics. The levels of indebtedness appear slightly higher in Denmark, Norway and Sweden and hence closer to the Finnish level when using the banks' 'domestic credit' (chart 2) than by using the alternative proxy, banks' 'claims on private sector' (chart A3.12). Also the form of curves and timing of some turning points seem to be somewhat different for the two indebtedness variables.

expectations. They are published well in advance and are widely cited and commented on by experts in every country.

The income surprise variable for the corporate sector is originally divided in two parts, for practical reasons. The macro-level proxy variable is built on the published OECD data. The variable comprises the OECD forecast and realized GDP figures country by country. The OECD publishes percentage change figures for both GDP volume and the GDP deflator separately. Both the actual outcome and the OECD forecast of the percentage change in GDP volume are shown in chart 5.

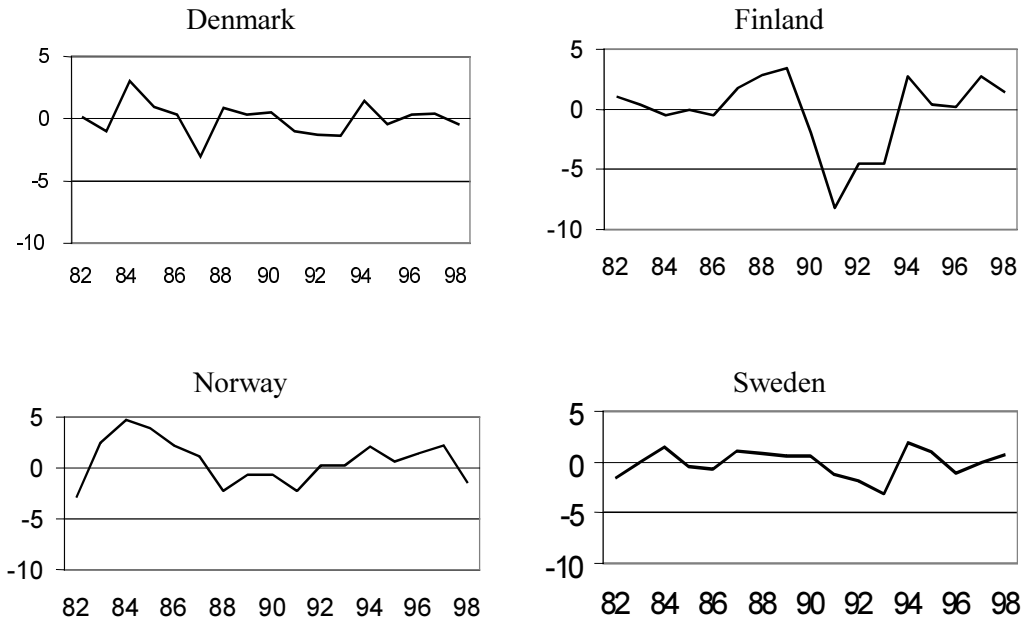
The volume component of the income surprise variable (YQS) is calculated for each country as the difference between percentage change in actual GDP volume (YQMP) and its forecast value published in June of the preceding year (YQJ1). Thus, YQS = YQMP–YQJ1. Its annual time series for 1982–2000 for all four countries separately is presented in chart 6. A negative value means a negative income surprise for the corporate sector, regarding the volume component of income, as actual outcome remains smaller than predicted change in GDP volume.

Chart 5. **GDP volume percentage change and OECD forecast**



1 GDP volume percentage change
2 OECD forecast

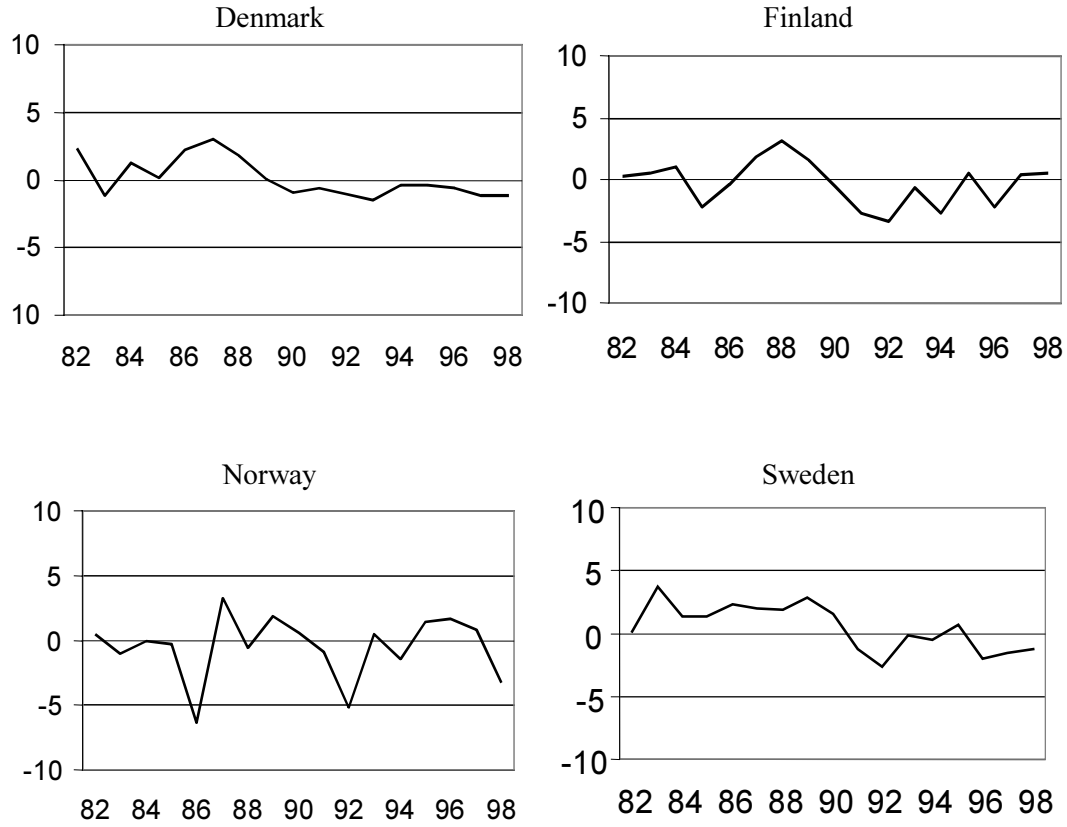
Chart 6. **GDP volume surprise variable.**
Difference between actual and predicted



It is visually clear that both the amplitude and timing of surprises differ between the countries (chart 6). Finland has suffered from the biggest single disappointment, 8 percentage points in 1991. That negative surprise was followed by two years of disappointment. In both years, the size of the disappointment was over 4 percentage points, clearly larger than the biggest ones in the other Nordic countries, which were some 3 percentage points, at most.

The proxy for the price component of the corporate income surprise variable (YPS) is constructed analogously with that of the volume component. It is the difference between the actual GDP deflator (YPF) and its OECD forecast published in June of the preceding year (YPJ1). The income price surprise variable, YPS = YPF–YPJ1, is depicted in chart 7.

Chart 7. **GDP price surprise variable. Difference between actual and predicted**



Source: OECD Economic Outlook

The interpretation of the YPS variable is less clear-cut than that of the volume component. The interpretation depends, among other things, on whether the cost or income component dominates in the GDP deflator, from the viewpoint of corporate sector. Namely, if the income component dominates, a negative value means a negative surprise. If the cost component dominates, a negative value means a positive surprise, as firms' actual costs are smaller than the predicted ones. The actual direction of explanation remains to be seen in the estimation results. For the real value of debt, however, the effect is of course clear.

Regarding price developments, it is also possible to use the corresponding OECD consumer price index data. Although the same identification problem regarding the direction of explanation is valid in principle here too, the income component could perhaps be more dominant here than in the GDP deflator.

The oscillation of the income price surprise variable based on the GDP deflator is widest in Norway (chart 7). The variation range is from 4 to –6 percentage points in Norway, while it oscillates between some 3 and –3 percentage points in the other Nordic Countries. The Norwegian oil industry might be responsible for the difference. All countries except for Denmark experienced relatively large negative values of income price surprise in the early 1990s. The preceding economic overheating can be traced in the large and persistent positive values in particular in Denmark, Finland and Sweden in the latter half of the 1980s.

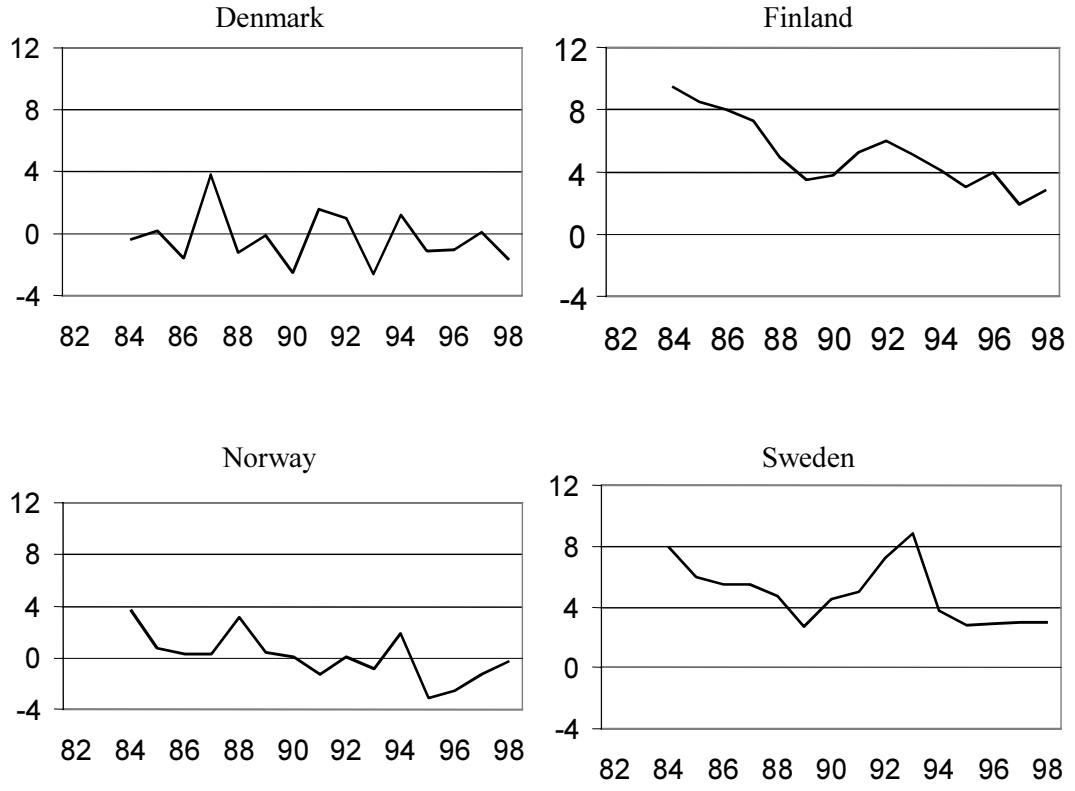
The bank lending rate (RL) is the basic interest rate variable in this study. The statistical source is the IFS. As we are ultimately trying to detect the surprise effect of the interest rate, the change in the nominal bank lending rate can be used as the surprise variable, according to the reasoning of section 4.1. Static expectations are allowed by assuming random walk interest rates and rigid expectations formation based on lagged behaviour from the preceding period of strict financial regulation.

The rate change, RLE (= RL–RL (–1)), is shown in chart A3.5. Because the majority of loan contracts include a flexible interest rate clause, it is correct to assume that a change in the rate effectively measures the capital costs of a leveraged firm.

Some estimation experiments were also done using the money market rate. This nevertheless did not statistically improve the estimation results.

Because there is an expected price component in the income surprise variable, it is rather natural to ask whether the same component is included in interest rate expectations. In that case, only the real part of the change in the interest rate would add to the explanation in the model. In order to detect this effect, we construct variables that catch changes in real bank lending rate. In chart 8 one such variable is shown. There, the change in OECD GDP deflator forecast, YPJ1–YPJ1 (–1), is subtracted form the change in nominal lending rate, RLE–YPJ1 + YPJ1 (–1).

Chart 8. **Change in real bank lending interest rate, based on OECD price (GDP deflator) forecast**



Source: IFS. OECD.

An alternative variable for describing changes in the real bank lending rate was also constructed. There, the difference in the actual GDP deflator, YP–YP (–1), is subtracted from the RLE. The variable however did not statistically improve the estimation results.

A negative change in the interest rate is a positive surprise to the debtor, because the debt service burden decreases. Looking at changes in the nominal rate, gives one the impression that positive surprises generally dominate (chart A3.5). This might reflect the fact that inflation was on a downward trend throughout the estimation period. The price level increased generally by some 10% in the Nordic countries in the early 1980s and has come down to about 1 to 3% nowadays.

The picture is different when we look at the real interest rate (chart 8). Positive changes are dominant in that case. Sweden in particular experienced a rather drastic real interest rate shock in the early 1990s, regardless of how it is measured. When measured eg with expected (OECD) prices, the real increase in the lending rate was some 7 percentage points in 1992, following by an almost 9 percentage point increase the next year (chart 8). In Finland, there has been a series of successive, albeit diminishing, real interest rate shocks throughout the estimation period, as measured in the same way. A similar, but not as clear, trend can be seen for Norway, and perhaps for Sweden.

C. Additional variables

It is assumed here that expectations for exchange rates and terms of trade, like the interest rate, are static. A change in the exchange rate is a surprise, as is a change in the terms of trade.

The nominal trade-weighted effective exchange rate for each country is plotted in chart A3.6. The statistical source is the IFS. A negative change in the variable means a devaluation of the currency and thus a negative surprise to a debtor who has borrowed in foreign currency. Both the Finnish and Swedish currencies were devaluated drastically in the early 1990s, while exchange rate movements in Denmark and Norway have been rather moderate.

The terms of trade variable was derived from the OECD sources. It was calculated by dividing the country's export price index by the corresponding import price index and taking the percentage change from it. A positive change in the terms of trade gives the country, ceteris paribus, a higher net income and hence is a positive surprise. In chart A3.7 we see that the terms of trade moved favourably for Denmark, Finland and Sweden in the latter part of the 1980s, while Norway suffered from a drastic negative shock in 1986, due to the collapse of the oil price in that year. All the countries except Denmark have experienced quite variable developments in their terms of trade in the 1990s.

The OECD forecasts of GDP volume and price components, YQJ1 and YPJ1, are econometrically tested in the models in order to detect a possible expectation effect on bankruptcies and loan losses. As discussed in section 4.1 expectations of exceptionally vigorous growth can start a lending boom that introduces the element of increased problems of asymmetric information.

Percentage change in lagged GDP is an alternative variable for the income expectation variable. Percentage changes in GDP volume were negative both in

Finland and Sweden in the early 1990s after a period of rapid growth. Finland's economic depression was particularly severe. GDP volume diminished in the three successive years, 1990 to 1993, by a total of over 12%. In Denmark and Norway the recession came earlier and was milder (chart 5). As can be seen in the chart, the OECD has usually failed to forecast sharp changes in GDP growth. This is particularly true for the fast-growth period in Norway and Finland in the 1980s and the sharp contraction of GDP in Finland and Sweden in the early 1990s.

4.3 Econometric estimation

4.3.1 Ex ante assumptions on the signs of the parameter coefficients

The first task is to estimate the basic equation based on the above discussion, which includes all the crucial explanatory variables in additive form so as to enable determination of the separate explanatory power of each variable. The key variables and expected signs of the estimated parameter coefficients (above the variable symbol), assuming an additive form of function (no cross terms) for banks' loan losses/outstanding lending stock (later denoted loan losses or LTL) are:

$$\begin{array}{cccccccccccc} & & + & & - & ?(+) & ? & ? & + & - & - & + & + \\ \mathrm{LTL} = & f(& \mathrm{LTL}(-1), & & \mathrm{YQS}, & \mathrm{YQJ1}, & \mathrm{YPS}, & \mathrm{YPJ1}, & \mathrm{RLE}, & \mathrm{ES}, & \mathrm{TS}, & \mathrm{LYV}(-1), & \mathrm{DRV}) \end{array}$$

where:

YQS = GDP volume surprise
YQJ1 = OECD forecast from June of preceding year for GDP volume percentage change (GDP volume expectation)
YPS = GDP deflator surprise
YPJ1 = OECD forecast from June of preceding year for GDP deflator percentage change (inflation expectation)
RLE = percentage point change in banks nominal lending rate (interest rate expectation)
ES = change in nominal trade-weighted effective exchange rate
TS = change in terms of trade
LYV = banks' outstanding lending stock/nominal GDP (aggregate indebtedness)
DRV = regulation dummy (0 during regulation period, 1 otherwise)

The same structure is valid with enterprise bankruptcies/population, BRP, as the dependent variable (later denoted bankruptcies or BRP).

Changes in the independent variables are reflected in the direction of change in loan losses or bankruptcies, given by the sign above the variable symbol. The indebtedness variable is lagged by one year, because it is assumed to be known at the moment of borrowing.

The deregulation dummy is set at 0 for the period of financial regulation and 1 otherwise. The timing of financial deregulation in the Nordic countries is shown in appendix 2. For Denmark, the dummy value is 1 throughout the estimation period. For Finland, the year of change is 1987. The dummy value is 0 until 1986

and 1 in 1987 and thereafter. The corresponding year of change is 1986 for both Norway and Sweden, when their period of the deregulated financial market regime is deemed to have begun. For example, Ongena, Smith and Michalsen place the most rapid financial liberalization phase in Norway between the years 1984 and 1986.[73]

4.3.2 Estimation results

Some correlation analysis was done before starting the regression analysis. Country-specific correlation results between dependent variable (in this case banks' loan losses/total assets) and certain independent variables are presented in table A3.2. The correlation signs are mostly as expected, except for the exchange rate (expected: negative) and banks' lending rate (expected: positive) for Denmark and Norway. The rather low correlation between loan losses and bankruptcies in Norway was noted earlier.

Both seemingly unrelated regression (SUR) and unweighted panel least squares (PLS) are applied in the panel regression analysis. Parallel estimation is done for the dependent variables ratio of banks' loan losses to lending (LTL) and ratio of number of enterprise bankruptcies to population (BRP, see section 4.3.1 or the key for estimation results in appendix 4, where all the variable abbreviations are shown). That could serve as a kind of a rough robustness check for the estimation results. We could say that the more closely the results resemble each other, the more reliable the resulting estimated structure, even when bearing in mind the earlier mentioned differences between the two depended variables. Some of the estimation results are shown in appendix 4.

The first step was to estimate the basic equation, presented in section 4.3.1. That equation includes all the crucial explanatory variables in additive form so as to enable determination of the separate explanatory power of each of the variables (table 3). The generally high total explanatory power (R-squared) is slightly higher in the bankruptcy equations than in the loan loss equations. The D-W statistics point to the absence of autocorrelation in the loan loss equation.[74] The signs of the coefficients are as expected, but note that the ex ante assumption about the sign of price variables (YPS and YPJ1) is ambiguous, as discussed in section 4.2.2.B. The price variable can reflect either income or cost expectations with opposite signs.

[73] Ongena-Smith-Michalsen (2000, p. 5).

[74] Remember however that the Durbin-Watson statistics is not likely to be valid for the equation with the lagged dependent variable on the right-hand side. It can be biased toward a finding of no autocorrelation. See eg Greene: Econometric Analysis, New Jersey, 2000 (fourth edition, p. 542).

Table 3. **Regression analysis: Dependent variable: Banks' loan losses/lending, LTL or enterprise bankruptcies/population, BRP**
Panel estimation with data from the Nordic countries

Method	SUR		PLS		SUR		PLS	
Dependent variable	LTL		LTL		BRP		BRP	
Variable	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
LTL(–1) or BRP(–1)	0.67	9.04**	0.59	6.55**	0.66	11.95**	0.73	11.90**
YQS	–0.15	–3.76**	–0.15	–2.14*	–0.04	–6.61**	–0.03	–3.30**
YQJ1	–0.18	–2.10*	–0.21	–1.50	–0.07	–5.49**	–0.06	–2.97**
YPS	–0.05	–1.20	–0.08	–1.21	–0.01	–1.97	–0.01	–1.51
YPJ1	0.07	1.32	0.07	0.79	0.00	–0.23	0.02	1.39
RLE(–1)	0.04	0.61	0.04	0.36	0.02	2.60*	0.03	1.99
LYV(–1)	3.01	2.22*	4.78	2.31*	0.24	1.00	0.42	1.47
DRV	–0.06	–0.17	–0.08	–0.18	0.06	1.12	0.09	1.41
Adj R^2	0.68		0.69		0.91		0.92	
DW	1.95		1.92		1.21		1.46	

Wald Test

	SUR/LTL			
Null Hypothesis:	F-statistic	Prob.	Chi-square	Prob.
YQS = YQJ1	0.17	0.68	0.17	0.68
YPS = YPJ1	3.84	0.06	3.84	0.05
	SUR/BRP			
Null Hypothesis:	F-statistic	Prob.	Chi-square	Prob.
YQS = YQS1	4.81*	0.03	4.84*	0.03
YPS = YPJ1	1.15	0.29	1.15	0.28

Sample period: 1983–1998.
Total panel observations 63.
SUR = Seemingly unrelated regression, PLS = Pooled least squares, no weighting, BRP = Number of firm bankruptcies per capita (source: Nordic central banks), DRV = Regulation dummy (DK=1, FI=1, y .87–98, NO and SW=1, y. 86–98), LTL = Banks' loan losses / lending (source: Nordic central banks), LYV = Banks' lending divided by GDP value (source: IFS), RLE = Change in nominal interest rate on bank lending, percentage point (source: IFS), YPJ1 = OECD forecast for GDP deflator percentage change, made in June Preceding year (source: OECD), YPS = GDP price surprise (YPF–YPJ1), YQJ1 = OECD forecast for GDP volume percentage change, made in June preceding year (source: OECD) and YQS = GDP volume surprise (YQMP–YQJ1).

Regarding the individual variables, the coefficient of the lagged dependent variable is significant in all estimated equations. Also the coefficient of the GDP volume surprise variable (YQS) is significant. The SUR method (first and second columns in table 3) should, with panel data, give more precise coefficients, as it takes into account possible contemporaneous correlation between countries.[75] As a small, fairly homogeneous open area, the Nordic countries can be affected by a common outside factor that is neglected here. Furthermore, as close neighbouring countries, their trade and other economic ties make the contagion of events between the countries fast and easy. The SUR estimation can eg take such omitted factors into account in this particular case.

The proxy for indebtedness (LYV) gets a statistically significant coefficient in the loan loss equations, while the surprise variable for the interest rate (RLE) does so only in the bankruptcy equations when it is lagged by one year. The price variables (both surprise, YPS, and OECD forecast, YPJ1) generally have weak explanatory power. The dummy variable for deregulation (DRV) did not contribute significantly to the explanation.

[75] See eg Greene (2000, p. 614–623).

In addition, a Wald test was performed in order to test whether the coefficient of the surprise variable is as big as the coefficient of the OECD forecast (table 3). We are thus testing eg whether the regression coefficient of YQS is the same size as the coefficient of YQJ1. According to the test results, the coefficients of price surprise and OECD forecast are equal in size, while the hypothesis of equality cannot be shown between the corresponding GDP volume variables. As the coefficients of both price variables also have opposite signs, one may suspect that the expectations and surprises outweigh each other.

In section 3.3 it was concluded that heavy indebtedness makes a firm or any other economic agent vulnerable to surprises. Thus a matter of concern is the joint effect of fragility and shock where the indebtedness amplifies the effect of surprises. That is why we have linked the lagged proxy for indebtedness directly to the surprise variables as cross terms in table A4.1, as the next step. The debt variable is again lagged by one year as a predetermined state variable.

The results resemble those in table 3 with the difference that now also the coefficient of interest rate surprise variable is mostly statistically significant. However, this result was reached again only by lagging the variable by one year. The built-in sign ambiguity probably causes the relatively weak performance of the price-related variables.

We now consider some potential additional variables. Many firms, also in the sheltered sector, incurred debts denominated in foreign currency after the deregulation of the late 1980s, particularly in Finland.[76] The subsequent devaluations of national currencies in the early 1990s suddenly increased the debt burdens of many firms. This might have pushed some of them into financial stress. Thus, changes in the exchange rate could explain some of the bankruptcies and loan losses.

Another explaining factor could be the terms of trade. Terms of trade developed favourably in the Nordic countries during the 1980s, which could have led to excessive investment and heavy indebtedness, causing bankruptcies and loan losses later on.

These additional variables were added to the models presented in table A4.2, but their coefficients are not statistically significant. Moreover, the coefficient of the exchange rate in some cases even gets a positive sign, which is not the expected result. A positive sign of course can be correct, since a devaluation boosts the income of exporting firms and so bankruptcies and loan losses will decrease in that way. Consequently, the expected sign can actually be ambiguous in this case.

A country-specific OLS estimation experiment was done in this connection in order to detect whether some of these additional variables would contribute for any country. The results suggest that the exchange rate variable received the negative sign but was insignificant for Finland. For the other countries the results were even poorer.

The final preferred model was derived as follows. Informed by the preceding experiments, the next step was to remove the ambiguous price expectation variable. The GDP expectation variable was changed to the lagged percentage change in GDP. Five years lag was used in order to capture the effect of the strong

[76] See Brunila-Takala: Private Indebtedness and the Banking Crisis in Finland, 1993, Bank of Finland Discussion Papers 9/93, pp. 24–27.

economic boom in the late 1980s.[77] The surprise variable was reconstructed by combining the quantity and price surprise variables. This new variable is an income surprise variable. Moreover, a real interest rate surprise variable replaced the nominal interest rate. Both surprise variables were multiplied by lagged indebtedness.

The results from this a kind of basic model for both loan losses divided by lending (LTL) and the number of bankruptcies divided by population (BRP) are presented in table 4 and in the fitted graphs (charts A4.1 and A4.2). As a summary, the estimated SUR regression equation on loan losses, LTL, is presented (t-values below in parentheses):

$$\mathrm{LTL} = \underset{(8.9)^{**}}{0.5} \cdot \mathrm{LTL}_{-1} + \underset{(3.6)^{**}}{0.1} \cdot \mathrm{YQ}_{-5} - \underset{(6.1)^{**}}{0.2} \cdot (\mathrm{YS} \cdot \mathrm{LYV}_{-1}) + \underset{(5.4)^{**}}{0.3} \cdot (\mathrm{RS}_{-1} \cdot \mathrm{LYV}_{-1}) + \underset{(4.4)^{**}}{1.0} \cdot \mathrm{DR}$$

where:

LTL = banks' loan losses/outstanding lending stock
YQ = YQMP = GDP volume, percentage change
YS = (YQS+YPS) = GDP value surprise (proxy for income surprise)
LYV = banks' lending divided by GDP value (proxy for D/W)
RS_{-1} = (RLE(–1)–YPJ1+YPJ1(–1)) = change in real interest rate (lagged by one year)
DR = DRV = regulation dummy
Adjusted R-squared: 0.73

The total explanatory power (R-squared) is satisfactory and the signs of the regression coefficients are as expected. All of the SUR coefficients for loan losses, as well as bankruptcies, are statistically significant.[78]

[77] For example in Finland the time lag between the peaks in total lending and loan losses was some four years during the recent banking crisis, see Pesola (2000, p. 18).

[78] There are also country specific fixed-effect coefficients that in the panel estimation reveal mainly differences between countries in 'loan loss or bankruptcy propensity'. According to those coefficients, if all the explanatory variables were zero, Sweden would have the highest degree of loan losses and bankruptcies. In contrast, Denmark's 'bankruptcy propensity' is very small. These results match the visual impression in Charts 3 and 4 and might be caused mainly by structural differences.

Table 4. **Regression analysis: Dependent variable: Banks' loan losses/lending, LTL or number of enterprise bankruptcies per capita, BRP**
Panel estimation with data from the Nordic Countries

Method	SUR		PLS		SUR		PLS	
Dependent variable	LTL		LTL		BRP		BRP	
Variable	coefficient	t-statistic	coefficient	t-statistic	coefficient	t-statistic	coefficient	t-statistic
LTL(–1) or BRP(–1)	0.55	8.93**	0.59	7.94**	0.60	12.20**	0.65	10.87**
YQMP(–5)	0.12	3.65**	0.13	2.72**	0.02	3.39**	0.02	2.55*
(YQS+YPS) ·LYV(–1)	–0.18	–6.08**	–0.19	–3.60**	–0.04	–7.33**	–0.04	–4.52**
(RLE(–1)–YPJ1 +YPJ1(–1)) ·LYV(–1)	0.34	5.44**	0.37	3.75**	0.05	4.25**	0.06	3.22**
DRV	0.98	4.45**	0.84	2.36*	0.23	4.81**	0.22	3.30**
Adj R^2	0.73		0.73		0.90		0.90	
DW	1.87		2.02		1.17		1.31	

Sample period: 1983–1998.
Total panel (unbalanced) observations 63.
SUR = Seemingly unrelated regression; PLS = Pooled least squares, no weighting; LTL(–1) = Banks' loan losses (–1)/lending (–1); BRP(–1) = Number of enterprise bankruptcies per capita (–1); YQMP(–5) = GDP volume, percentage change (–5); (YQS+YPS)·LYV(–1) = (income surprise)·(lending (–1)/GDP(–1)); (RLE(–1)-YPJ1+YPJ1(–1))·LYV(–1) = (real interest rate, change)·(lending(–1)/GDP(–1)); DRV = Regulation dummy.

There are some peaks in fitted graphs (charts A4.1 and A4.2), which the estimated model is not able to catch. The most notably unexplained peaks are left to Sweden. Perhaps Sweden has some specific structural features as it has the highest relative figures both in loan losses and bankruptcies (see charts 3 and 4). Furthermore, there is some extra variation in the fitted curve, particularly in the 1980s. It might be that the regulation still limited the behaviour of banks, so that not all the loan losses were revealed or realised.

According to the estimation results, it seems that both the lagged effect of economic boom and shocks combined with financial fragility have significantly contributed to bankruptcies and loan losses during the period of financial liberalisation and the following banking crises in the Nordic countries. Also the regulation dummy gets a statistically significant coefficient. It thus seems eg that the financial liberalisation increased the amount of loan losses generated from the banks' outstanding lending stock by 1%. However, one should be cautious in interpreting, because the effect of deregulation is included also in the other independent variables. The lagged dependent variable is a strong explanatory variable, for both loan losses and bankruptcies, which could point to the existence of a feedback effect.

An interesting question is why the lagged actual GDP volume produces better results than the unlagged OECD forecast of GDP made in the preceding year, which also gets a coefficient with a correct sign but is slightly less significant. Both results indicate an overheated lending boom in the Nordic countries in the manner discussed in section 4.1. The answer can be found, at least partly, in chart 5 where we can see that the OECD forecast (GDP expectations) do not vary much. In contrast, the actual GDP outcome does vary and thus catches better the explanation of relaxed loan standards inducing a lending boom.

Moreover, if there is a vigorous upswing and growing market bubble, as was the case in the Nordic countries prior to the crises, a big change in activity can be initially hidden in the surprise variable, as both the expectations and actual outcome move in the same direction. In other words, the surprise will be delayed in this case and the pure expectations account for more of the explanation at the outset.

Another curiosity is that the interest rate variable gets a far more significant coefficient in lagged than unlagged form. The result is the same regardless of whether a real or nominal rate is used. The initial implication is that the surprise element might not be very pronounced, but it might be a question of relatively slow adjustment by the economic agents leading to bankruptcies and loan losses.

Further experiments did not contribute significantly to the results. For instance, removing countries one by one from the estimation did not help in detecting weak points in the explanation, in respect of either countries or variables. Yet, there were some vague signs that dropping out Denmark from the estimation of loan loss equation raised somewhat the model's total explanatory power and the significance of the coefficients of the combined shock-fragility variables. A similar effect could nevertheless not be detected in the bankruptcy equation.

In addition, some further experiments were done using either nonlinear variables and using the Generalized Method of Moments estimation method. These further estimation experiments did not materially alter the earlier results. It might be that further experiments with quarterly data could contribute to more precise results, but compiling such data would go beyond the scope of this study.

5 Conclusion

The structure of the study was as follows. First, some basic facts about the Nordic financial liberalisation and banking crises were surveyed. The main findings were that there was an overheated lending boom caused by the preceding liberalisation, which was not skilfully conducted, except in Denmark. This led to asset price bubbles as banks' lending standards were relaxed. Loan losses and bankruptcies were selected as crisis indicators.

Second, explanatory factors for loan losses and bankruptcies were sought from both the theoretical literature and empirical research reports. The joint effect of financial fragility and macroeconomic shocks were found to be the main explanatory factors for movements in the selected financial crisis indicators. Financial fragility was defined as debt/asset-relation and was proxied in empirical tests by aggregate indebtedness, ie bank lending/GDP. According to the debt deflation approach, fragility can change rather quickly with variations in asset values, whereas the amount of debt is more rigid.

Third, a panel estimation was done using macroeconomic data from the Nordic countries. According to the empirical results, it seems that high indebtedness combined with negative economic shocks or surprises caused the recent banking crises in three Nordic countries, Sweden, Norway and Finland. Although no direct effect of external factors on banking crises could be econometrically traced, an indirect effect is possible through the surprise variables. For example, the market interest rate increased sharply in connection

with devaluation speculations triggered by a deteriorating outlook. That was also reflected in banks' lending rates.

A parsimonious econometric model was estimated using panel data for four Nordic countries. The dependent variable was banks' loan losses divided by lending or, alternatively, enterprise bankruptcies divided by population. The explanatory variables were, the lagged dependent variable, lagged GDP percentage change, the income surprise variable combined with lagged indebtedness, change in the real interest rate combined with lagged indebtedness, and a deregulation dummy. The total explanatory power of the model is relatively high.

The toughest test for an estimated econometric model is to use it in an out-of-sample situation. It is nevertheless hard to do an out-of-sample evaluation because there has been no crisis since the crisis of the 1990s in the Nordic countries. Another possibility would be to try to apply the results to some other similar country that has experienced a banking crisis. According to the literature, there would perhaps be a couple of other European countries suitable for the out-of-sample check. Such experiments must however be left to other studies. One possible demonstration of robustness would be estimation results for both loan losses and bankruptcies that are similar regardless of differences between those variables.

An interesting question is: Why did Denmark not experience a banking crisis in the 1990s? It seems that the economic surprises were smaller there and that the initial debt burden was lighter. This was the result of, among other things, earlier financial deregulation and a different economic policy regime, as Denmark belonged to the ERM. Moreover, liberalisation was carried out more skilfully in Denmark than in the other Nordic countries. For example, the regulation environment was relatively quickly reshaped according to the new circumstances.

As surprises seem to be the ultimate reason for banking crisis, it is very difficult to predict a crisis. On the other hand, it should be fairly easy to monitor indicators of crisis probability or vulnerability such as level of indebtedness or asset prices. It should in principle be possible to construct some alarm limits for a threatening crisis. A bit more difficult would be to assess whether the banks' lending policy has eased and hence increased the probability of crisis. For instance, Keeton uses survey results to assess banks' lending policy.[79]

As a general conclusion one can say that it is important to conduct an economic policy which produces as stable as possible an economic environment, in order to avoid surprises. For Finland, belonging to the EMU is one way of doing this as is for Denmark participation in ERM2. Another question is how to prevent an unduly increase in the financial fragility. And for this financial regulation must carry a heavy responsibility.

[79] Keeton's source of information is the Senior Loan Officer Survey conducted by the Federal Reserve since 1967. See Keeton (1999, p. 64).

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Appendix 1

Summary of macroprudential indicators

Aggregated microprudential indicators	Macroeconomic indicators
Capital adequacy Aggregate capital ratios Frequency distribution of capital ratios	Economic growth Aggregate growth rates Sectoral slumps
Asset quality *Lending institution* Sectoral credit concentration Foreign currency-denominated lending Nonperforming loans and provisions Loans to loss-making public sector entities Risk profile of assets Connected lending Leverage ratios *Borrowing entity* Debt-equity ratios Corporate profitability Other indicators of corporate conditions Household indebtedness	Balance of payments Current account deficit Foreign exchange reserve adequacy External debt (including maturity structure) Terms of trade Composition and maturity of capital flows Inflation Volatility in inflation Interest and exchange rates Volatility in interest and exchange rates Level of domestic real interest rates Exchange rate sustainability Exchange rate guarantees Lending and asset price booms Lending booms Asset price booms Contagion effects Trade spillovers Financial market correlation Other factors Directed lending and investment Government recourse to the banking system Arrears in the economy
Management soundness Expense ratios Earnings per employee Growth in the number of financial institutions	
Earnings and profitability Return on assets Return on equity Income and expense ratios Structural profitability indicators	
Liquidity Central bank credit to financial institutions Segmentation of interbank rates Deposits in relation to monetary aggregates Loans-to-deposit ratios Maturity structure of assets and liabilities (liquid asset ratios) Measures of secondary market liquidity	
Sensitivity to market risk Foreign exchange risk Interest rate risk Equity price risk Commodity price risk	
Market-based indicators Market prices of financial instruments, including equity Indicators of excess yields Credit ratings Sovereign yield spreads	

Source: IMF (2000) Macroprudential Indicators of Financial System Soundness. Occasional Paper No. 192, Washington D.C.

Appendix 2

Financial liberalization in the Nordic countries

Denmark: liberalization measures (Source: Danmarks Nationalbank)

Bank regulation:

- Until 1980 the commerical banks faced a bank lending ceiling.
- The banks have since 1981 been unrestricted in their choice of lending rates.
- In 1987 the Danish Parliament adopted the law regarding deposit insurance.
- The restrictions for international capital flows inside EU were removed by 1 January 1993.
- In 1991 the international capital rules (own fond directive) were implemented in Danish legialation.

The deregulation increased the compoetition among Danish banks but did not cause an explosive development in credit growth compared to the situation in other Nordic countries.
There are mainly two reasons for this. First, the deregulation was not as radical compared to the deregulation in other Nordic countries. Secondly, the Danish banks were more accustomed to operating in a competitive market than were the banks in the other Nordic countries.

Foreign exchange regulation:

The foreign exchange regulation was removed in 1988 after a gradual liberalisation during the sixties, seventies and eighties.

Finland: chronology of selected liberalization measures (Source: Drees–Pazarbasioglu, 1998)

1982	Foreign banks were permitted to open subsidiaries.
1984	Banks were allowed to lend abroad and to invest in foreign securities.
1986	The average bank lending rate was permitted to exceed by 1.75 percentage points the Bank of Finland base rate or by 50 basis points the average deposit rate on markka deposits. Later that year, regulations on average bank lending rates were abolished. Long-term foreign borrowing by manufacturing and shipping companies was exempted from exchange control regulations.
1987	The Bank of Finland began open market operations in bank CDs in the money market. Helibor money market rates were introduced. Credit guidelines were discontinued. Requirements on down payments on housing loans and consumer loans were eliminated. Restrictions on long-term foreign borrowing by corporations were lifted.
1988	Floating rates were allowed on all loans. Banks were permitted to use long-term market rates as loan reference rates.
1989	A supplementary reserve requirement linked to lending growth was introduced. Remaining regulations on foreign currency loans were abolished, except for households.
1990	Prime rates were allowed as loan reference rates.
1991	Cross-border short-term capital movements were liberalized. Private households were allowed to raise foreign-currency-denominated loans.

Norway: chronology of selected liberalization measures (Source: Drees–Pazarbasioglu, 1998)	
1980	The rates for individual loans were not regulated; rather the average level was regulated through interest rate declarations from the Ministry of Finance. Foreign borrowing by banks was liberalized. Under the new foreign exchange legislation, foreign currency exposure limits were established on banks; however, because the Norges Bank provided currency swaps, this measure imposed no constraint on banks' foreign borrowing.
1984	Supplementary reserve requirements were removed.
1985	Interest rate declarations were removed and interest rate monitoring was introduced. The bond investment requirement was phased out.
1986	Supplementary reserve requirements were reintroduced. The limits on the commercial and savings bank borrowing facility at the Norges Bank were increased markedly. Foreign banks were permitted to open subsidiaries.
1987	The supplementary reserve requirements were removed. Perpetual subordinate capital was excluded from the limitations on approved loan capital. The Banking, Insurance, and Securities Commission issued guideliness for assessing nonperforming loans and entering them in accounts.
1989–1991	Remaining foreign exchange controls were removed.
1990	Foreign banks were allowed to operate through branch offices.

Sweden: chronology of selected liberalization measures (Source: Drees–Pazarbasioglu, 1998)	
1978	Ceilings on bank deposit interest rates were abolished.[1]
1980	Ceilings on issuing rates for private sector bonds were lifted. Controls on lending rates for insurance companies were removed. A tax on bank issues of certificates of deposit was removed. Foreigners were allowed to hold Swedish shares.
1982	Ceiligs on new bond issues by private companies were removed.
1983	Requirements on banks to hold government and housing bonds to meet liquidity quotas were abolished. Use of liquidity ratios to guide bank lending was discontinued and replaced by recommended growth rates for lending.
1985	Ceilings on bank loan rates were lifted.
1986	Placement ratios for banks and insurance companies were abolished. Foreign banks were allowed to establish subsidiaries in Sweden.
1986–1988	Foreign exchange controls on stock transactions were relaxed.
1988–1989	Swedish residents were allowed to buy foreign shares.
1989	Foreigners were allowed to buy interest-bearing assets denominated in Swedish kronor. Remaining foreign exchange controls were removed.
1988–1991	Cash reserve requirements were introduced for finance companies in 1988 and abolished in 1991.
1990	Foreign banks were allowed to operate through branch offices and were entitled to participate in the Riksbank's clearing system on the same terms as Swedish banks.

[1] However, interbank agreements linking deposit rates to the discount rate continued for some years.

Appendix 3

Table A3.1 **Pairwise Granger Causality Tests**

Null Hypothesis	Obs	F-Statistic	Probability
Denmark			
BR does not Granger Cause LT	14	14.2256	0.00309
LT does not Granger Cause BR		4.89053	0.04909
Finland			
BR does not Granger Cause LT	16	7.46302	0.01712
LT does not Granger Cause BR		2.73688	0.12199
Norway			
BR does not Granger Cause LT	15	1.20419	0.29402
LT does not Granger Cause BR		5.83822	0.03254
Sweden			
BR does not Granger Cause LT	16	0.29459	0.59647
LT does not Granger Cause BR		0.00117	0.97324

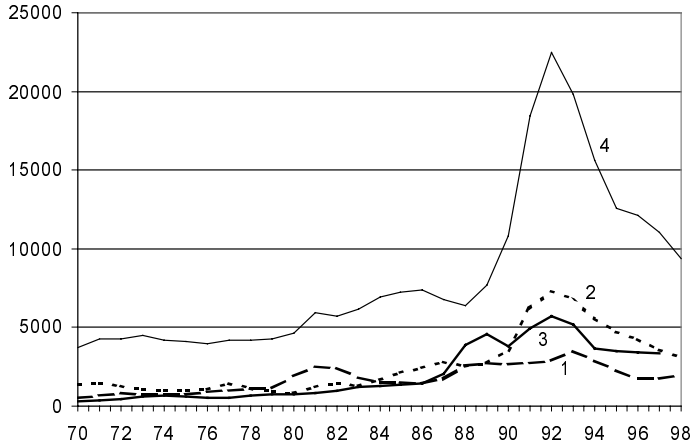
Sample period 1982–1998
BR = bankruptcies
LT = loan losses

Table A3.2 **Correlations for the 1980s and 1990s**

	Denmark	Finland	Norway	Sweden
LTA/BR	0.77	0.91	0.59	0.89
LTA/GDP Volume surprise	–0.07	–0.50	–0.55	–0.69
BR/GDP Volume surprise	–0.26	–0.61	–0.45	–0.47
LTA/GDP Price surprise	–0.44	–0.52	–0.10	–0.47
BR/GDP Price surprise	–0.45	–0.63	–0.04	–0.71
LTA/CPI surprise	–0.46	0.16	–0.08	–0.12
BR/CPI surprise	–0.35	0.14	–0.39	–0.41
LTA/NEUMP	0.22	–0.51	0.07	–0.20
BR/NEUMP	0.17	–0.42	0.36	–0.05
LTA/RL	–0.18	0.24	0.57	0.12
BR/RL	–0.02	0.15	–0.17	–0.15
LTA/TTMP	–0.18	–0.35	–0.07	–0.28

LTA = Banks' loan losses/total assets (annual average) according to Nordic Central Banks.
BR = Number of bankruptcies
NEUMP = Nominal effective exchange rates, percentage change (trade weights)
RL = Nominal interest rate of bank lending, %
TTMP = Terms of trade, percentage change
surprise = Actual observation – OECD forecast in june preceding year

Chart A3.1 **Bankruptcies in the Nordic countries, number**

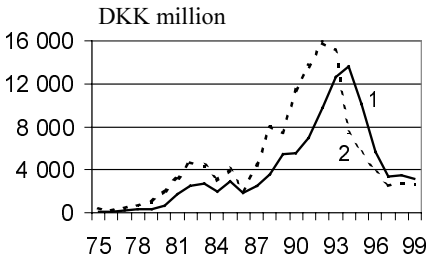


1 Danmark
2 Finland
3 Norway
4 Sweden

Source: Kari Takala – Matti Virén: Maksuhäiriöiden ennakointi toimialoittain, Velkakierre, No. 25, November 2000.

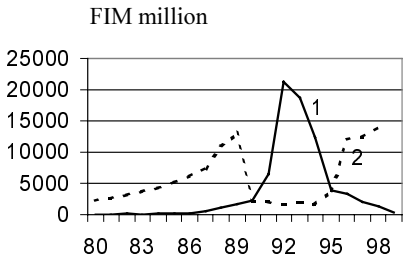
Chart A3.2 **Banks' loan loss provisions and loan losses**

Denmark



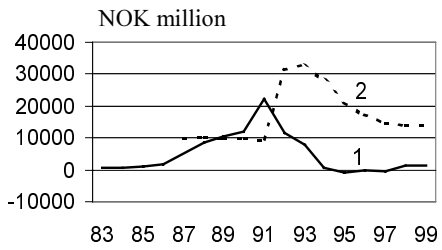
1 Loan losses
2 Loan loss provisions

Finland



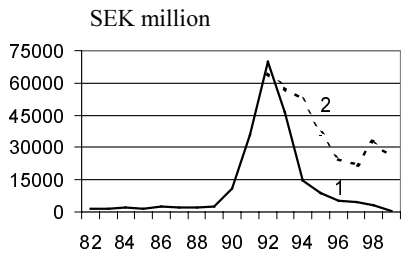
1 Loan losses
2 Provision for loan losses (total)

Norway



1 Loan losses
2 Provision for loan losses (total)

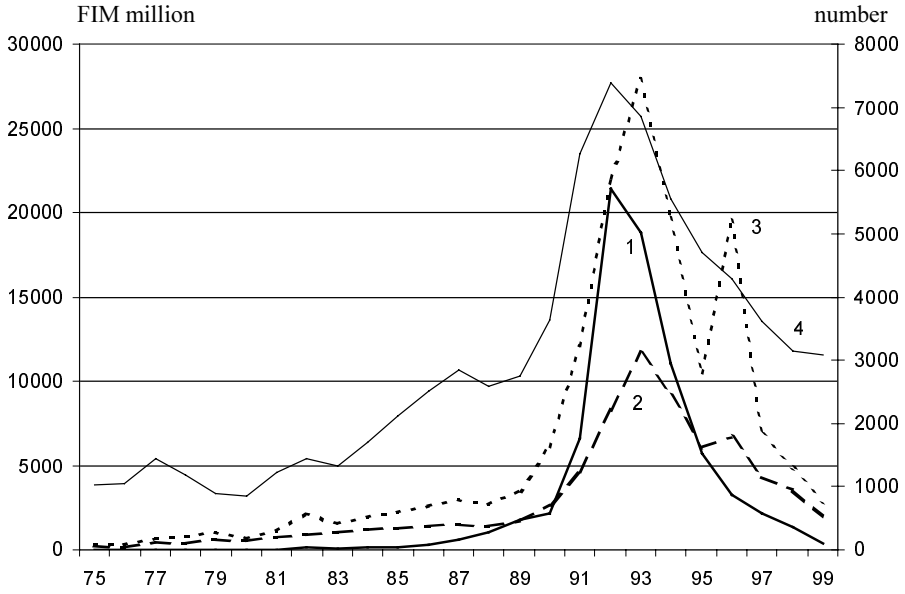
Sweden



1 Loan losses
2 Reserve for possible lending losses

Source: The Nordic central banks and the OECD

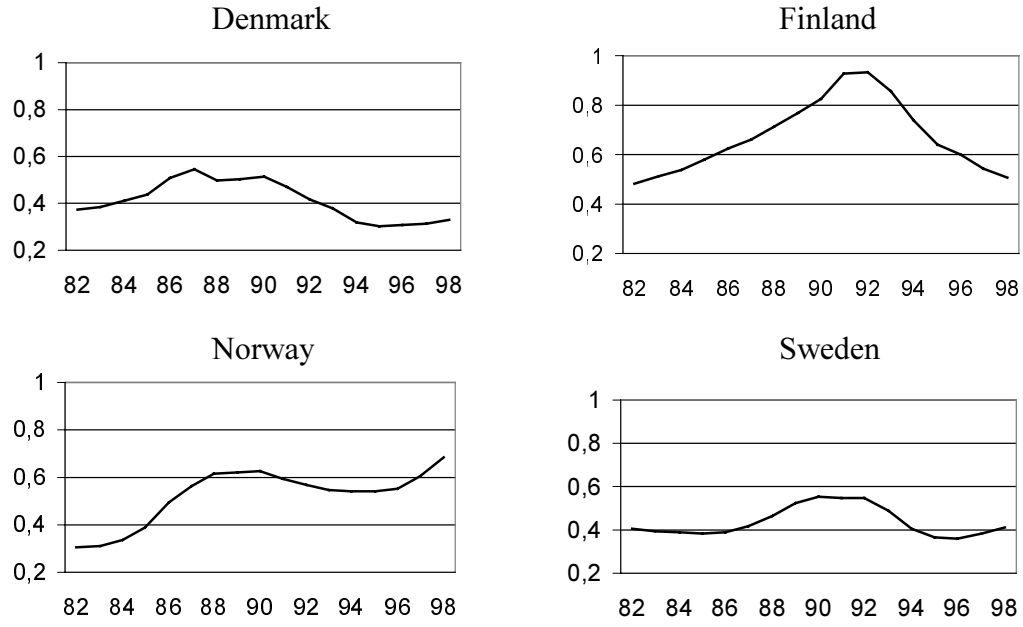
Chart A3.3 **Enterprise bankruptcies and banks' loan losses in Finland**



1 Banks' loan losses (left scale)
2 Debt minus assets in bankrupt enterprises (left scale)
3 Debt in bankrupt enterprises (left scale)
4 Enterprise bankruptcies (right scale)

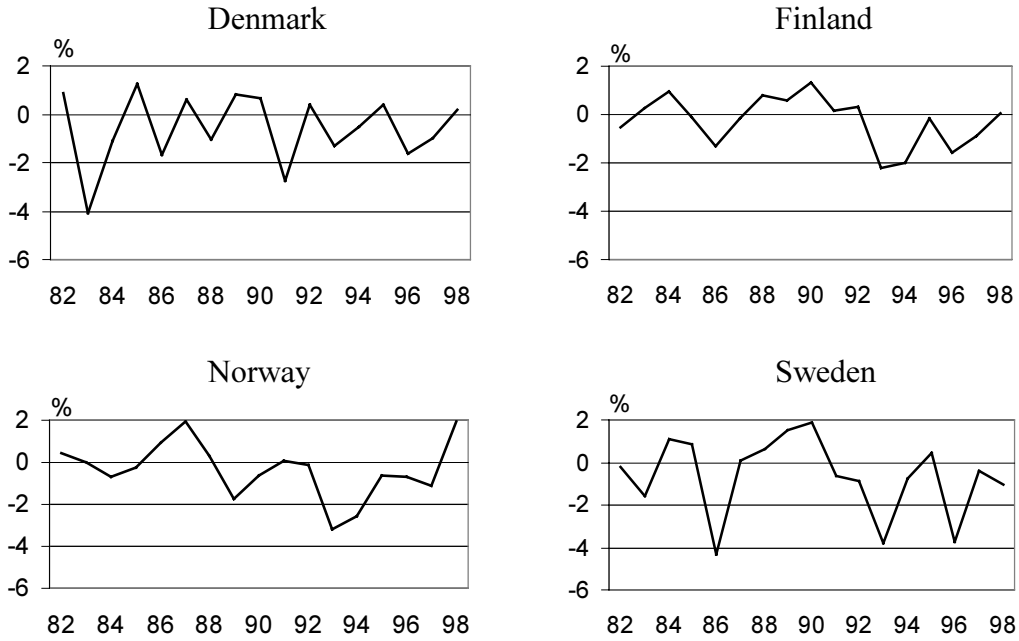
Source: Statistic Finland, Bank of Finland. Takala–Virén: Maksuhäiriöiden ennakointi toimialoittain, Velkakierre, No. 25, November 2000.

Chart A3.4 **Banks' lending to private sector divided by GDP value**



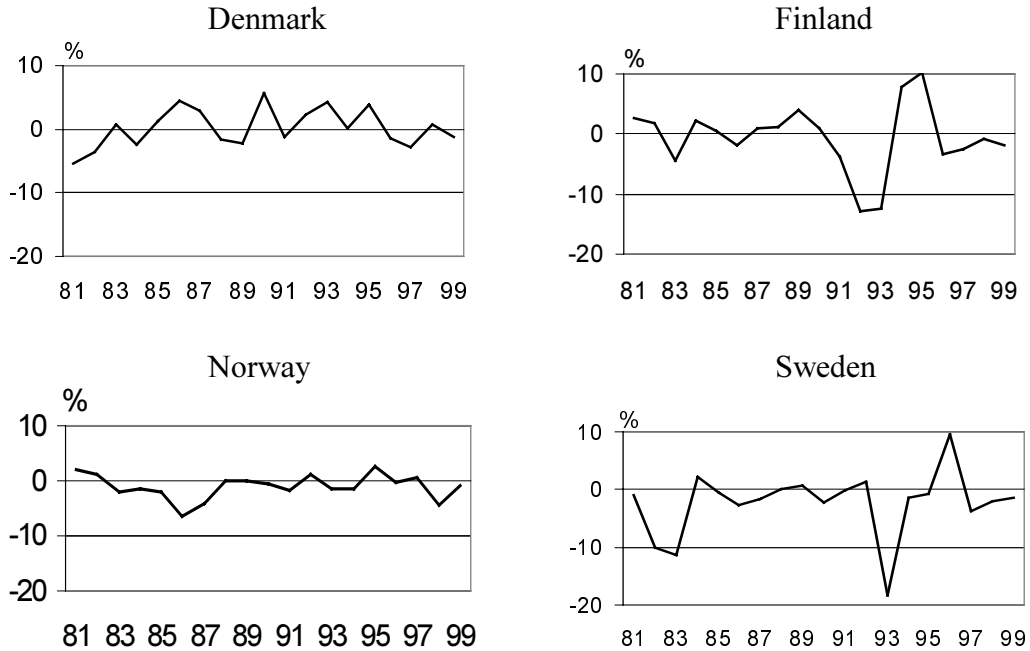
Source: IFS

Chart A3.5 **Change in nominal bank lending interest rate (RLE = interest rate surprise)**



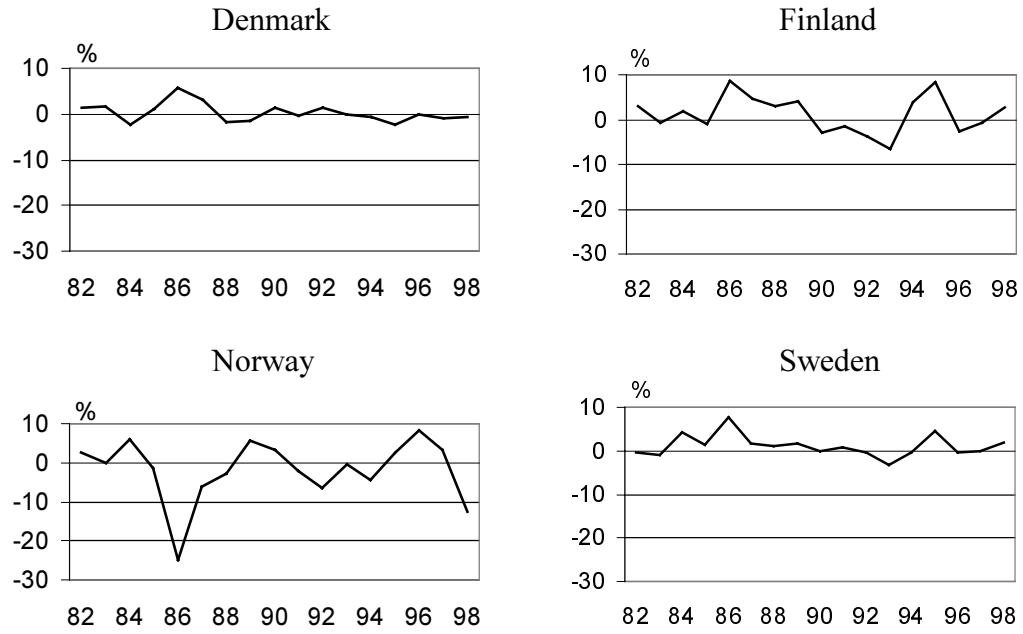
Source: IFS

Chart A3.6 **Effective exchange rate, percentage change (nominal, trade weighted)**



Source: IFS

Chart A3.7 **Terms on trade, percentage change**



Source: OECD

Appendix 4

Key for estimation results

BRP	Number of firm bankruptcies per capita (source: Nordic central banks)
DRV	Regulation dummy (DK = 1, FI = 1, y. 1987–1998, NO and SW = 1, y. 1986–1998; zero otherwise)
LTL	Banks' loan losses / lending (source: Nordic central banks)
LYV	Banks' lending divided by GDP value (source: IFS)
NEUMP	Nominal effective exchange rate, percentage change, trade weighted (source: IFS)
RLE	Change in nominal interest rate on bank lending, percentage point (source: IFS)
RME	Change in nominal money market rate, percentage point (source: IFS)
TTMP	Terms of trade, percentage change (source: OECD)
YPF	GDP deflator, percentage change (source: OECD)
YPJ1	OECD forecast for GDP deflator percentage change, made in June preceding year (source: OECD)
YPS	GDP price surprise (YPF–YPJ1)
YQJ1	OECD forecast for GDP volume percentage change, made in June preceding year (source: OECD)
YQMP	GDP volume, percentage change (source: IFS)
YQS	GDP volume surprise (YQMP–YQJ1)

Table A4.1 **Regression analysis: Dependent variable: Banks' loan losses/lending, LTL or enterprise bankruptcies/population, BRP**
Panel estimation with data from the Nordic Countries

Method	**SUR**		**PLS**		**SUR**		**PLS**	
Dependent variable	LTL		LTL		BRP		BRP	
Variable	coefficient	t-statistic	coefficient	t-statistic	coefficient	t-statistic	coefficient	t-statistic
LTL(–1) or BRP(–1)	0.69	12.46**	0.66	7.75**	0.66	13.18**	0.75	12.27**
YQS·LYV(–1)	–0.27	–6.38**	–0.30	–3.40**	–0.06	–7.34**	–0.05	–3.74**
YQJ1	–0.28	–4.07**	–0.29	–2.23*	–0.06	–5.82**	–0.06	–3.26**
YPS· LYV(–1)	–0.09	–1.82	–0.12	–1.19	–0.02	–2.31*	–0.03	–1.69
YPJ1	0.02	0.39	0.05	0.52	0.00	–0.50	0.02	1.18
RLE(–1) ·LYV(–1)	0.17	2.05*	0.11	0.75	0.04	2.89**	0.06	2.58*
DRV	0.35	1.38	0.29	0.68	0.09	1.97	0.13	2.02*
Adj. R^2	0.67		0.68		0.91		0.92	
DW	2.05		2.05		1.19		1.48	

Sample period: 1983–1998.
Total panel observations 63.
SUR = Seemingly unrelated regression; PLS = Pooled least squares, no weighting; BRP = Number of firm bankruptcies per capita (source: Nordic central banks); DRV = Regulation dummy (DK = 1, FI = 1, y. 1987–1998, NO and SW = 1, y. 1986–1998; LTL = Banks' loan losses / lending (source: Nordic central banks); LYV = Banks' lending divided by GDP value (source: IFS); RLE = Change in nominal interest rate on bank lending, percentage point (source: IFS); YPJ1 = OECD forecast for GDP deflator percentage change, made in June preceding year (source:); YPS = GDP price surprise (YPF–YPJ1); YQJ1 = OECD forecast for GDP volume percentage change, made in June preceding year (source:); YQS = GDP volume surprise (YQMP–YQJ1).

Table A4.2 **Regression analysis: Dependent variable: Banks' loan losses/lending, LTL or enterprise bankruptcies/population, BRP. Panel estimation with data from the Nordic countries.**

Method	SUR		PLS		SUR		PLS		SUR		PLS		SUR		PLS	
Dependent variable	LTL		LTL		BRP		BRP		LTL		LTL		BRP		BRP	
Variable	Coef.	t-Stat.	Coef.	t-Stat.	Coef.	t-Stat.	Coef.	t-Stat.	Coef.	t-Stat.	Coef.	t-Stat.	Coef.	t-Stat.	Coef.	t-Stat.
LTL(–1) or	0.58	7.96**	0.62	7.36**					0.54	7.58**	0.62	7.55**				
BRP(–1)					0.59	10.67**	0.66	10.12**					0.58	10.68**	0.65	10.04**
(YQS+YPS)·LYV(–1)	–0.17	–5.86**	–0.20	–3.33**	–0.04	–8.14**	–0.04	–4.21**	–0.18	–6.20**	–0.20	–3.36**	–0.04	–8.17**	–0.05	–4.31**
(RLE(–1)–YPJ1+YPJ1(–1)) ·LYV(–1)	0.31	5.17**	0.37	3.37**	0.04	3.48**	0.06	3.00**	0.32	5.41**	0.38	3.39**	0.04	3.35**	0.06	2.94**
NEUMP(–2)	0.01	0.95	0.00	–0.17	0.00	0.31	0.00	0.21								
TTMP									0.00	–0.11	0.00	0.06	0.00	–0.51	0.00	–0.47
DRV	0.62	3.07**	0.51	1.26	0.15	3.52**	0.14	1.85	0.64	3.23**	0.50	1.25	0.15	3.52**	0.14	1.95
Adjusted R^2	0.68		0.69		0.88		0.89		0.68		0.69		0.88		0.89	
D-W stat.	1.69		1.87		0.98		1.20		1.65		1.88		0.97		1.19	

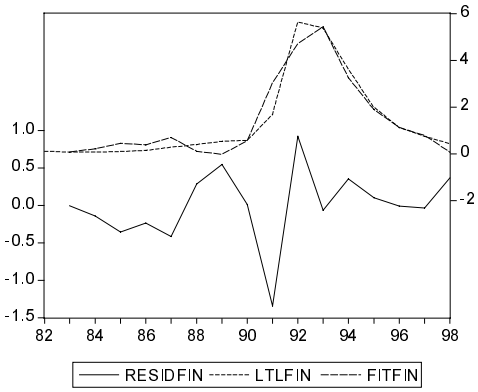
Sample: 1984–1998
Total panel (balanced) observat. 60/62

SUR = Seemingly unrelated regression
PLS = Pooled least squares, no weighting
BRP = Number of firm bankruptcies per capita (source: Nordic central banks)
DRV = Regulation dummy (DK = 1, FI = 1, y. 1987–1998, NO and SW = 1, y. 1986–1998)
LTL = Banks' loan losses / lending (source: Nordic central banks)
LYV = Banks' lending divided by GDP value (source: IFS)
NEUMP = Nominal effective exchange rate, percentage change, trade weighted (source: IFS)
RLE = Change in nominal interest rate on bank lending, percentage point (source: IFS)
TTMP = Terms of trade, percentage change (source: OECD)
YPJ1 = OECD forecast for GDP deflator percentage change, made in June preceding year (source: OECD)
YPS = GDP price surprise (YPF–YPJ1)
YQS = GDP volume surprise (YGMP–YQJ1)

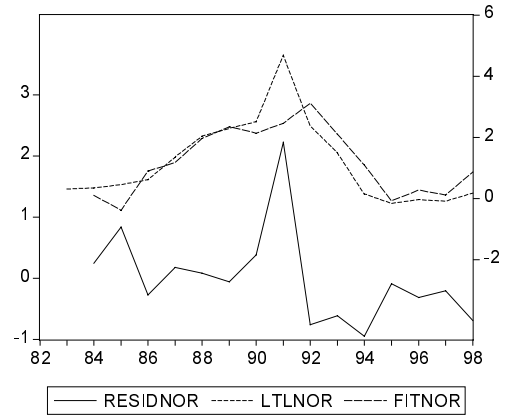
Chart A4.1 **Panel estimation of banks' loan losses / lending: country-by-country residuals and fitted graphs (SUR)**

Denmark

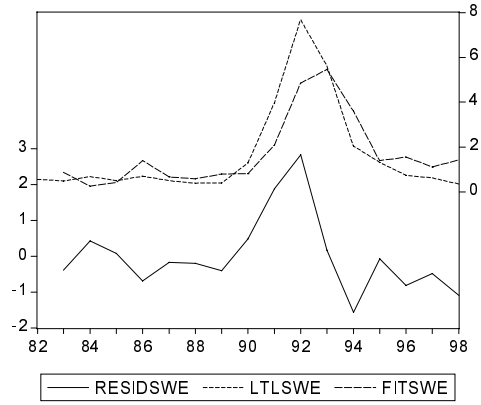
Finland



Norway



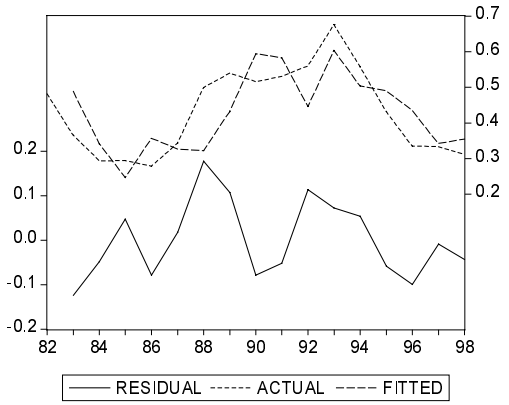
Sweden



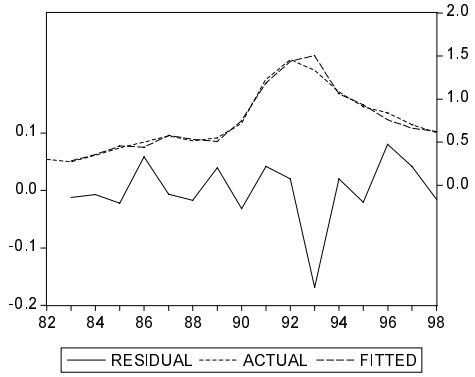
Legend: RESID = residual
LTL = actual
FIT = fitted

Chart A4.2 **Panel estimation of enterprise bankruptcies / population: country-by-country residuals and fitted graphs (SUR)**

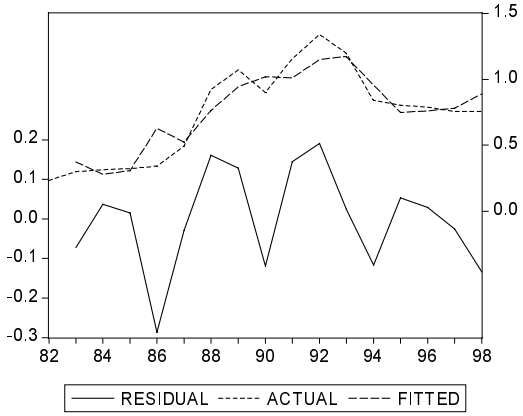
Denmark



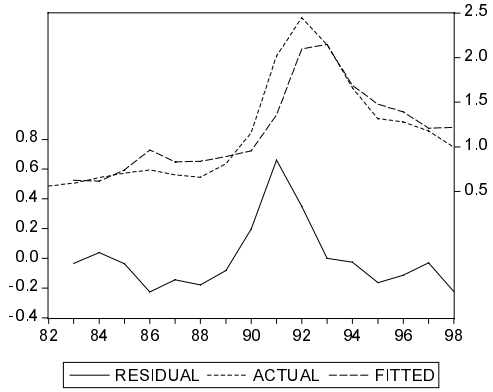
Finland



Norway



Sweden



Legend: RESID = residual
LTL = actual
FIT = fitted

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