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Financial Cycles and Bankruptcies in the Nordic Countries

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Financial cycles and bankruptcies in the Nordic countries

Jan Hansen*

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Abstract

This paper studies the relationship between macroeconomic imbalances and bankruptcies in the Nordic countries. Finland, Sweden, Norway and Denmark liberalised their financial markets during the 1980s and experienced the consecutive emergence of a financial cycle, followed by severe banking crises. Cointegration analysis and Granger causality tests suggest that the joint path of credit, house prices and possibly investment in construction relative to GDP creates macroeconomic imbalances and has high predictive power for bankruptcies. House prices appear to be most important. Several empirical results appear to be similar for Sweden, Finland and Norway, while patterns for Denmark often differ. The estimations indicate that macroeconomic imbalances were small at the end of 2001 in all four countries.

Keywords: Macroeconomic imbalances; financial distress; VAR model; cointegration.

JEL Classification: C22, E32, E44.

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1. Introduction

During the 1980s, the Nordic countries Finland, Norway, Sweden and Denmark liberalised their financial markets and experienced a consecutive period of large swings in credit, asset prices and economic activity.[1] The emergence of large macroeconomic imbalances, or what is sometimes called a financial cycle, were accompanied by a sharply increasing number of bankruptcies in the non-financial sector and severe banking crises. Similar developments at that time also occurred in other countries, notably the United Kingdom and Japan, but were particularly pronounced in the Nordic countries. In general, liberalisation of financial systems in recent decades in a wide number of countries appears to have increased the frequency and scope of financial cycles.[2]

The mutually reinforcing relationship between credit and asset prices lies at the heart of financial cycles.[3] A stylized scenario for a financial cycle might be outlined in the following way. The starting point is often some increase in the credit supply or banks' inclination to lend, perhaps due to structural changes in the financial sector. High credit growth can have a direct and indirect effect on asset prices. Agents may directly use credit to purchase real and financial assets. Indirectly, credit expansions fuel aggregate demand and tend to generate an upswing in economic activity, brightening expectations for future income on assets and buoying their valuation. In turn, higher asset values strengthen the net worth of agents and hence their borrowing capacity by increasing the value of collateral.

In later stages of the cycle, expectations might increasingly become disconnected from underlying fundamentals in the real economy. This sets the stage for a period of falling asset prices, declining or negative credit growth, falling demand and increasing failures in the non-financial sector. Sharply increasing bankruptcies in the non-financial sector may be related to widespread financial distress, if they adversely affect bank balance sheets.[4] The same factors that reinforced the upswing operate in reverse and exacerbate the downswing. Financial cycles amplify, and are amplified by, the business cycle, meaning that financial and real developments are mutually reinforcing.

The impact of credit and asset price booms on business cycles and financial distress was first fully articulated in Fisher's theory of debt-deflation (Fisher 1933) and has been developed further by Minsky (1977) and Kindleberger (1978). Since the late 1970s, several microeconomic approaches for explaining financial cycles and financial distress have been developed focusing on market imperfections. Guttentag and Herring (1984) apply a behavioural approach to explain why the degree of risk aversion within the financial system might develop procyclically, driving credit, asset prices and investment and subsequently causing financial distress.[5] Allen and Gale

[1] Financial deregulation in Denmark started earlier and was more prolonged.
[2] Borio et al (2001), BIS (2001).
[3] Borio et al (1994).
[4] Failures in the enterprise sector and resultant loan losses were the main source of eroding bank capital and weakness in the banking system in the Nordic countries during the financial crises. For relationships between bankruptcies and loan losses for banks in the Nordic countries see Pesola (2001). For a Swedish perspective, see also Jacobson and Lindé (2000).
[5] Se also Borio et al (2001).

(1999) constructed a model that explains how asymmetric information and limited liability in financial markets might lead to credit booms, asset price bubbles and finally financial distress. However, these approaches do not explicitly model, but rather assume, related developments in the real economy and financial distress.

Asymmetric information between lenders and borrowers in financial markets has often been shown to give rise to credit rationing.[6] One important implication, shown by Bernanke, Gertler and Gilchrist (1999), is that asset price developments are of crucial importance for credit growth due to their impact on borrowers' collateral values. This financial accelerator effect has been proposed as a common explanation for the pro-cyclicality of the financial system. Kiyotaki and Moore (1997) developed a model based on the financial accelerator that shows the simultaneous emergence of cycles in financial and real economic variables. Due to the real business cycle character of the model, the economy is always in equilibrium which leaves no room for an inefficient allocation of resources in the form of macroeconomic imbalances and financial distress.

In summary, various types of models explain important elements of financial cycles, but no theoretical framework exists that completely covers the stylized macroeconomic scenario outlined above.

Based on the study of financial crises and the experience of recent decades, Borio and Lowe (2002) have recently suggested that risks for financial instability increase substantially if "rapid credit growth, rapid increases in asset prices and, in some cases, high levels of investment" occur simultaneously. Lowe (2001) calls this the emergence of the "troublesome threesome". While strong gains in these variables might indicate the anticipation of higher sustainable growth, historical experience might, according to Borio and Lowe, argue against that. They emphasise that rapid credit growth, rapid increases in asset prices or an investment boom, by itself, may pose little threat to the stability of the financial system. Rather, it is the combination of these events that increases the likelihood of problems.

Among the "troublesome threesome", Lowe (2001) particularly refers to commercial property prices and investment in construction. Movements in property prices appear to have been more important for the development of financial cycles than equity prices. In most banking systems, real estate has a special role as the major form of loan collateral, and rapidly falling property prices might be related to many banking system problems.[7] In summary, Borio and Lowe's suggestion is an interesting attempt to put the term "financial cycle" into a more concrete form and offers a set of empirically testable hypotheses.

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[6] Stiglitz and Weiss (1981).

[7] A comparison between the Nordic countries, but also Japan and the United Kingdom, in the late 1980s and early 1990s and the United States in the late 1990s might illustrate this line of reasoning. As described in detail in Section 2, rapid increases in credit, property prices and investment in construction preceded banking crises in the Nordic countries. In contrast, property market-related developments during the boom years in the United States in the second half of the 1990s were more subdued, though share prices were rising rapidly. It has sometimes been suggested that the absence of imbalances in the real estate market, or two important elements of the "troublesome threesome", has diminished subsequent risks of financial distress.

The available literature offers several empirical studies on the determinants of bankruptcies, among others for the Nordic countries. The most common technique is to model the behaviour of an individual firm and test the resulting specification using macroeconomic data.[8] Pesola (2001), for example, estimated econometric models for the ratio of banks' loan losses to lending and enterprise bankruptcies per capita in the Nordic countries Finland, Sweden, Denmark and Norway on panel data from the 1980s and 1990s. He found indebtedness and growth shocks to be significant explanatory variables. Jacobson and Lindé (2000) concluded that macroeconomic developments can, to a large extent, explain the proportion of company bankruptcies in Sweden during the 1990s.

However, empirical studies on macroeconomic imbalances and bankruptcies (or financial distress in a wider sense) are rare, possibly due to a shortage of related theoretical models. Borio and Lowe (2002) found that the prediction of future problems in the financial system can be improved by combining "troublesome threesome" indicators, especially credit and asset prices, and focusing on cumulative processes. Their sample consisted of 34 countries, including all the G10, for the period 1960 to 1999.

The purpose of this paper is to add to the small body of literature on macroeconomic imbalances and bankruptcies. The paper studies the empirical relationships between financial cycles, i.e. movements in credit, asset prises and investment, and bankruptcies in the Nordic countries. More specifically, inspired by Borio and Lowe's suggestion on the "troublesome threesome", the main part of the paper derives hypotheses on relationships between credit, asset prices, investment and GDP and tests them by means of cointegration techniques. Then, Granger causality tests are performed within a vector error correction framework to examine if the "troublesome threesome" variables help to predict the number of bankruptcies per capita.

The paper finds evidence for Borio and Lowe's suggestion that macroeconomic imbalances are created by the joint path, rather than by the individual paths of credit, house prices and possibly investment in construction relative to GDP, and that they have high prediction value for bankruptcies. House prices appear to be most important. Several empirical results appear to be similar for Sweden, Finland and Norway, while patterns for Denmark often differ. The estimations indicate that macroeconomic imbalances were small at the end of 2001 in all four countries.

The remainder of this paper is organized as follows. Section 2 briefly describes macroeconomic developments in the Nordic countries during the 1980s and 1990s and presents graphs on the set of selected macroeconomic variables. Section 3 carries out an explorative data analysis for relationships between bankruptcies and macroeconomic variables by calculating leading and lagged correlation coefficients. The purpose of the tentative data analysis in Sections 2 and 3 is to establish some "stylized facts" on the relationships between the "troublesome threesome" and the number of bankruptcies. Section 4 is the main part of the paper and performs cointegration analysis and Granger causality tests. Section 5 summarises and concludes.

[8] Davis (1995).

2. Financial cycles and financial distress in the Nordic countries

This section gives a brief description of macroeconomic developments related to financial cycles and financial distress in the Nordic countries during the past 20 years. We also present graphs on relevant macroeconomic variables and derive some "stylized facts".

According to standard macroeconomic growth theory, the capital stock, investment and asset prices should grow in line with GDP in the long run.[9] This might also be a reasonable approximation for the volume of credit, if the financial structure (i.e. the debt/equity ratio) of the private sector is assumed to be constant. We therefore express credit, asset prices and investment as a share of GDP in order to provide some benchmark for "sustainability" of their development.

Housing assets are special because they might be viewed as either an investment or a consumption good. In this study, housing assets are treated purely as an asset implying that house prices in the long run should grow in line with nominal GDP instead of consumer prices. Therefore, results are reported for house prices relative to GDP.

Inflation is expressed as the quarterly growth in consumer prices. All variables except share prices and interest rates are seasonally adjusted.

Bankruptcy rates are likely to differ between countries according to bankruptcy law, the definition of failure and the corporate sector. Hence, caution is needed in making direct comparisons of levels. Moreover, certain changes to the bankruptcy law may impinge on the number of declared bankruptcies. However, these problems should not substantially influence the trends and determinants of failures across countries, which are the main focus for our analysis. In order to make some correction for changes in the size of the economy, bankruptcies are expressed in relation to population size.[10]

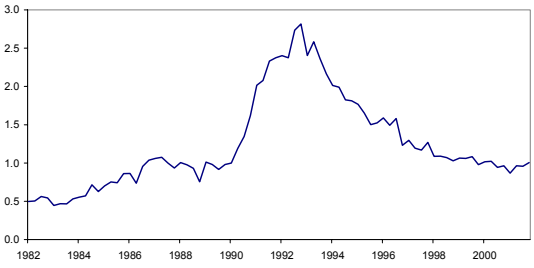
The variables that are included in our study consist of the number of bankruptcies per capita, lending to the private sector, share prices and house prices, investment in construction and machinery/equipment, GDP, inflation and short-term interest rates. Data sources are reported in Appendix A. Figures 1-4 provide graphs on their development in the Nordic countries for the past 20 years.

[9] Solow (1956) and McGrattan and Prescott (2000).

[10] In addition to bankruptcies, we tested two alternative measures for financial distress, namely the share price index of the banking sector in relation to either a broad share price index or nominal GDP. However, these time series do not appear to reflect expected developments of financial distress for the sample period. Correlation coefficients with our set of macroeconomic variables are inconclusive. Both variables have therefore been dropped from further considerations.

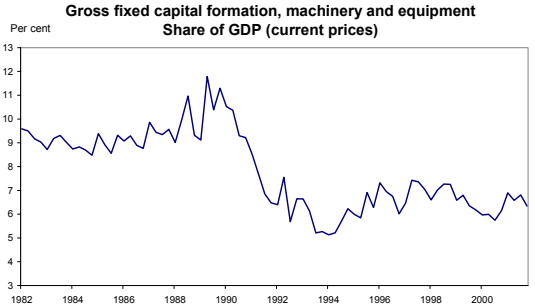
Figure 1: Macroeconomic developments in Finland

Bankruptcies per capita
(Index 1990Q1=1)



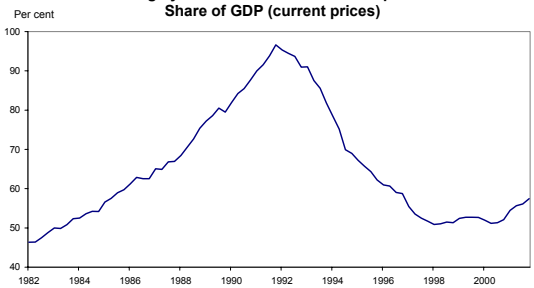
Sources: Bank of Finland, IMF and Sveriges Riksbank

Gross fixed capital formation, machinery and equipment
Share of GDP (current prices)



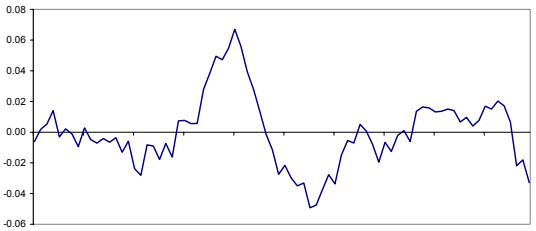
Sources: Hanson and Partners AB, OECD and Sveriges Riksbank

Total lending by all credit institutions to the private sector
Share of GDP (current prices)



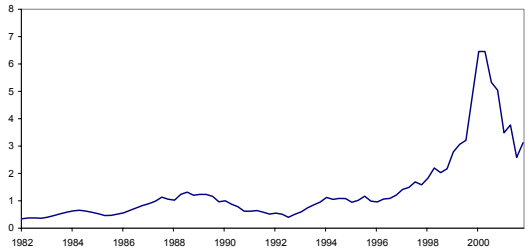
Sources: IMF, OECD and Sveriges Riksbank

Gross Domestic Product
Constant prices
Deviation from trend (logarithmic values)



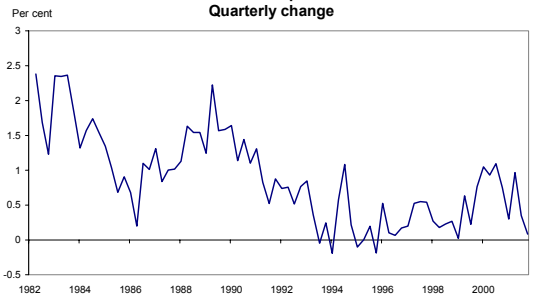
Sources: OECD and Sveriges Riksbank

Share prices
Ratio of GDP (current prices)
Index (1990Q1=1)



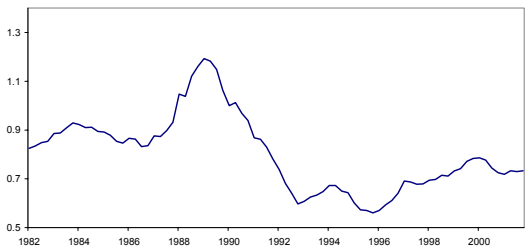
Sources: Hanson and Partners AB, OECD and Sveriges Riksbank

Consumer prices
Quarterly change



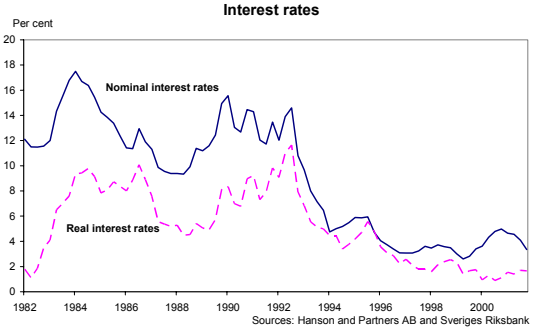
Sources: OECD and Sveriges Riksbank

House prices
Ratio of GDP (current prices)
Index (1990Q1=1)



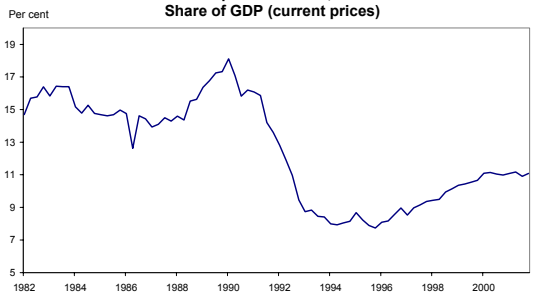
Sources: Bank of Finland, OECD and Sveriges Riksbank

Interest rates



Sources: Hanson and Partners AB and Sveriges Riksbank

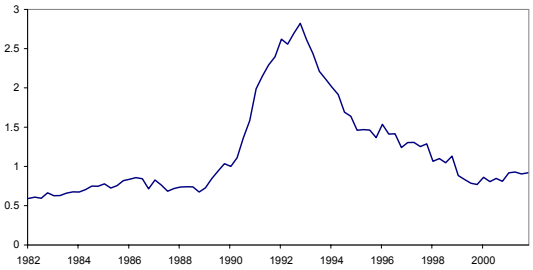
Gross fixed capital formation, construction
Share of GDP (current prices)



Sources: IMF, OECD and Sveriges Riksbank

Figure 2: Macroeconomic developments in Sweden

Bankruptcies per capita
(Index 1990Q1 = 1)

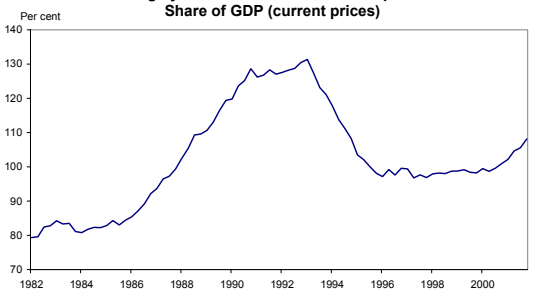


Source: Statistics Sweden, IMF and Sveriges Riksbank

Gross fixed capital formation, machinery and equipment
Share of GDP (current prices)

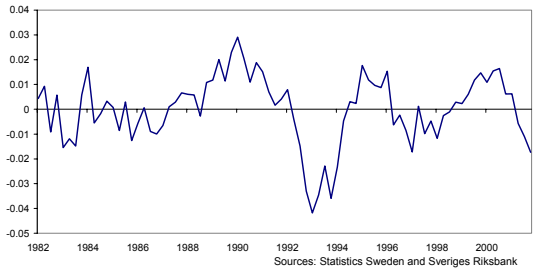
Source: Statistics Sweden and Sveriges Riksbank

Total lending by all credit institutions to the private sector
Share of GDP (current prices)



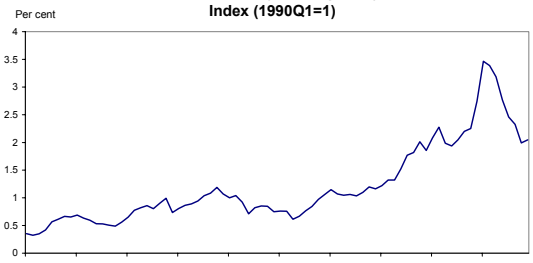
Source: Statistics Sweden and Sveriges Riksbank

Gross Domestic Product
Constant prices
Deviation from trend (logarithmic values)



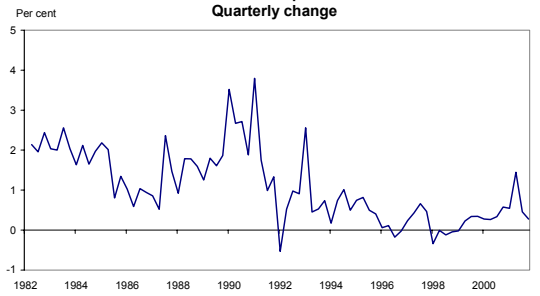
Sources: Statistics Sweden and Sveriges Riksbank

Share prices
Ratio of GDP (current prices)
Index (1990Q1=1)



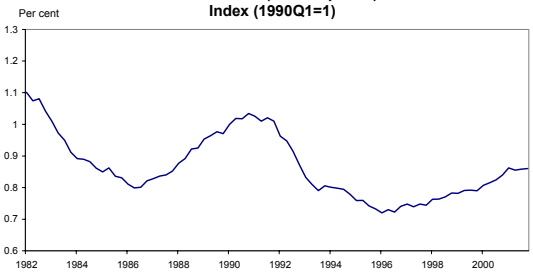
Source: Hanson & Partners AB, Statistics Sweden and Sveriges Riksbank

Consumer prices
Quarterly change



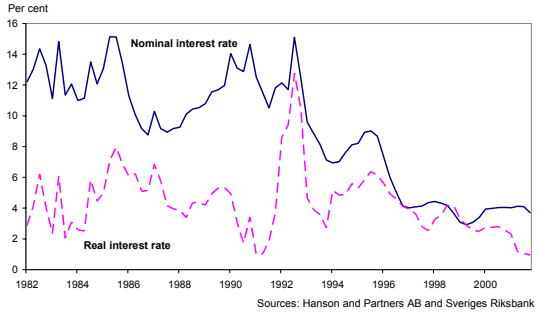
Source: Statistics Sweden and Sveriges Riksbank

House prices
Ratio of GDP (current prices)
Index (1990Q1=1)



Source: Statistics Sweden and Sveriges Riksbank

Interest rates



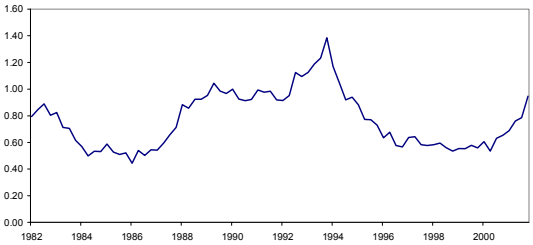
Sources: Hanson and Partners AB and Sveriges Riksbank

Gross fixed capital formation, construction
Share of GDP (current prices)

Source: Statistics Sweden and Sveriges Riksbank

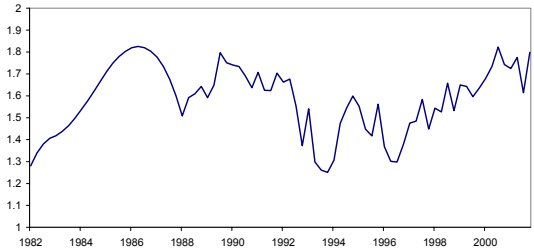
Figure 3: Macroeconomic developments in Denmark

Bankruptcies per capita
(Index 1990Q1=1)



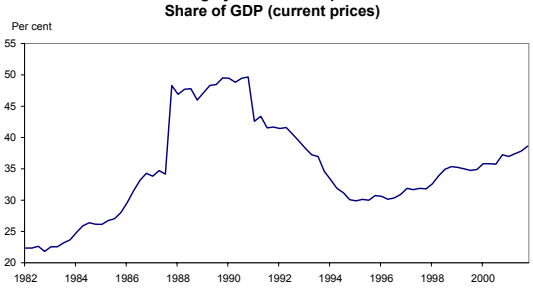
Source: Bank of Denmark, IMF and Sveriges Riksbank

Gross fixed capital formation, machinery and equipment
Share of GDP (current prices)



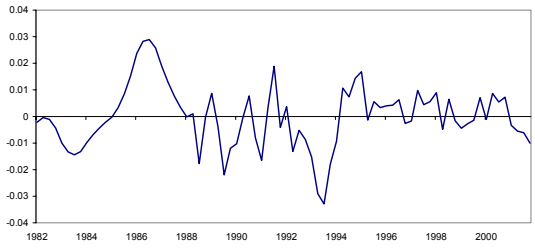
Sources: Statistics Danmark, OECD, Hanson and Partners AB and Sveriges Riksbank

Total lending by banks to the private sector
Share of GDP (current prices)



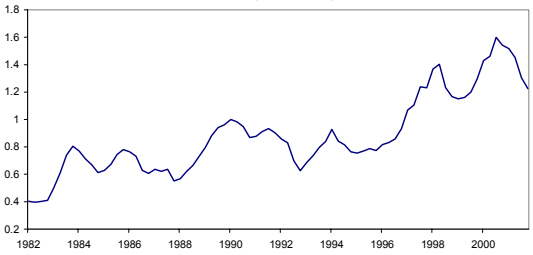
Sources: IMF, OECD and Sveriges Riksbank

Gross Domestic Product
Constant prices
Deviation from trend (logarithmic values)



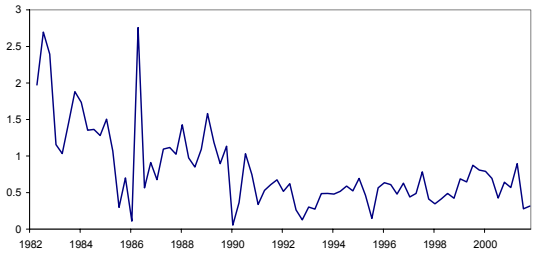
Sources: OECD and Sveriges Riksbank

Share prices
Ratio of GDP (current prices)
Index (1990Q1=1)



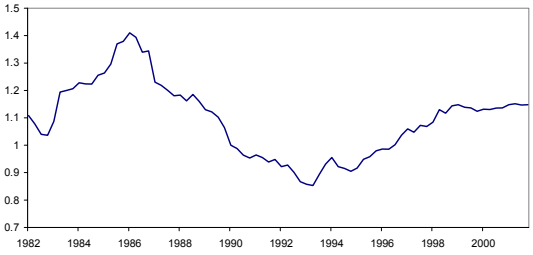
Sources: OECD, Hanson and Partners AB and Sveriges Riksbank

Consumer prices
Quarterly change



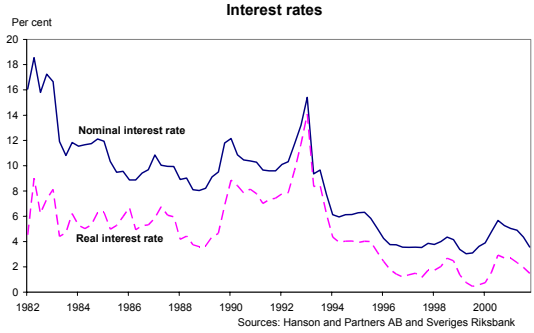
Sources: OECD and Sveriges Riksbank

House prices
Ratio of GDP (current prices)
Index (1990Q1=1)



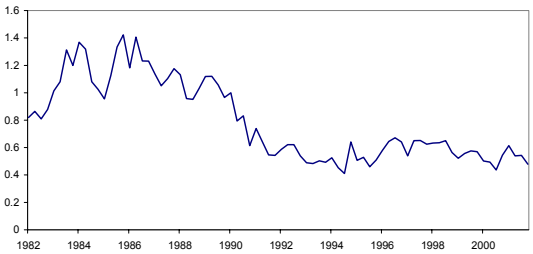
Sources: Bank of Denmark, Statistics Denmark, OECD and Sveriges Riksbank

Interest rates



Sources: Hanson and Partners AB and Sveriges Riksbank

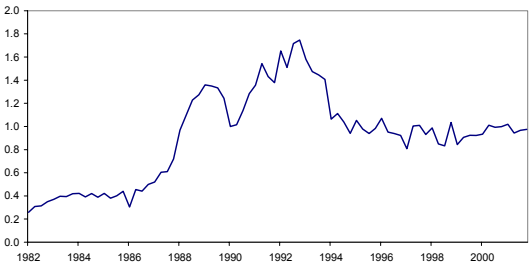
Construction of dwellings started relative GDP
Index (1990Q1=1)



Sources: Statistics Denmark, OECD and Sveriges Riksbank

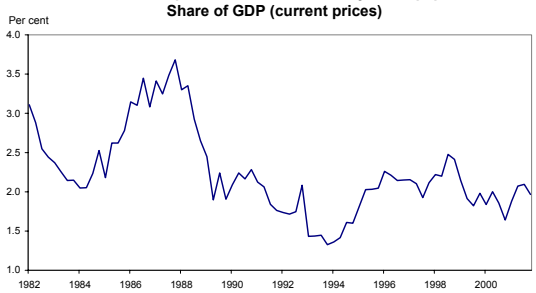
Figure 4: Macroeconomic developments in Norway

Bankruptcies per capita
(Index 1990Q1=1)



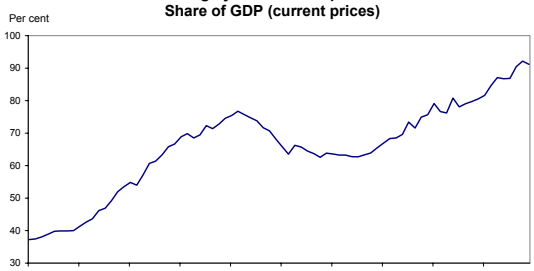
Source: Bank of Norway, IMF and Sveriges Riksbank

Gross fixed capital formation, machinery and equipment
Share of GDP (current prices)



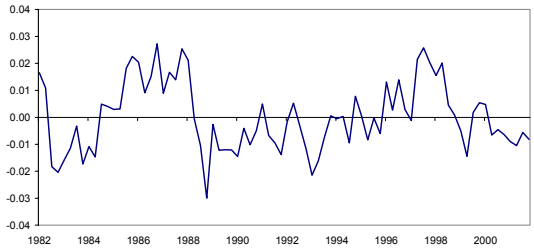
Sources: Hanson and Partners AB, OECD and Sveriges Riksbank

Total lending by banks to the private sector
Share of GDP (current prices)



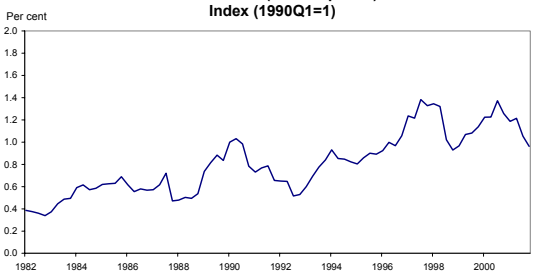
Sources: IMF, OECD and Sveriges Riksbank

Gross Domestic Product
Constant prices
Deviation from trend (logarithmic values)



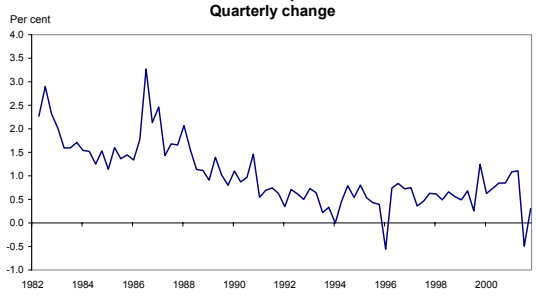
Source: OECD and Sveriges Riksbank

Share prices
Ratio of GDP (current prices)
Index (1990Q1=1)



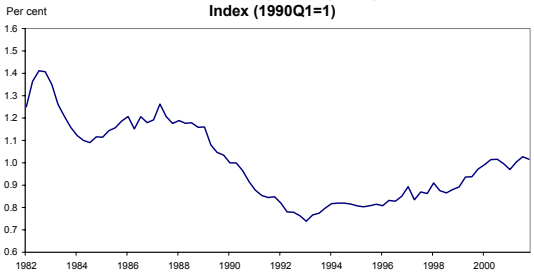
Sources: Hanson and Partners AB, OECD and Sveriges Riksbank

Consumer prices
Quarterly change



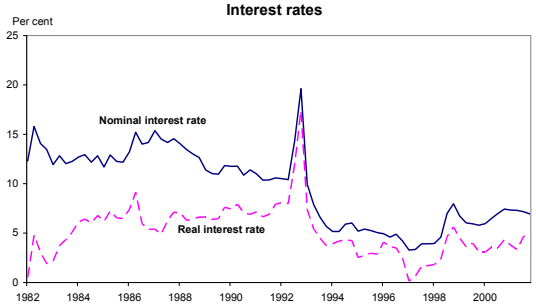
Sources: OECD and Sveriges Riksbank

House prices
Ratio of GDP (current prices)
Index (1990Q1=1)



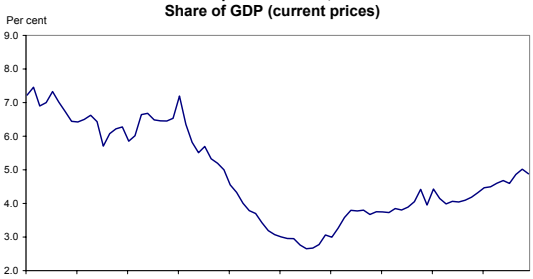
Sources: Bank of Norway, OECD and Sveriges Riksbank

Interest rates



Sources: Hanson and Partners AB and Sveriges Riksbank

Gross fixed capital formation, construction
Share of GDP (current prices)



Sources: Hanson and Partners AB, OECD and Sveriges Riksbank

Figures 1-4 show the development of a financial and real economic cycle and associated fluctuations in the number of bankruptcies in the four Nordic countries during the 1980s and early 1990s, possibly with the exception of Denmark.[11] Common to Finland, Sweden and Norway (but not Denmark) were significant structural changes in the financial sector around the mid-1980s, moving from a heavily regulated banking system where credit was rationed to one of open competition.

Due to the previous credit rationing, a substantial stock-adjustment response in private credit occurred after the liberalisation. High marginal tax rates and full tax deductibility of interest payments meant that real after-tax interest rates were very low and sometimes negative, which provided further incentives for borrowing. Demand for credit was also fuelled by robust economic growth at the time of liberalisation.

The initial surge in credit contributed to a jump in asset prices, in particular real estate prices. Expecting that the sharp asset price appreciation would continue along the prevailing trend, many borrowers were willing to further increase their debt burdens and a self-reinforcing process developed. A significant increase in private sector investment took place, with the majority occurring in residential and non-residential construction, real estate and services sectors, as well as consumer durables. Monetary policy options to limit the expansionary effects of deregulation were, however, constrained by fixed exchange rate regimes, and fiscal policies do not appear to have been tight enough.

In summary, financial liberalisation, adverse incentive structures and accommodative macroeconomic policies contributed significantly to the emergence of a financial cycle and made the economies more vulnerable to macroeconomic shocks.

The financial crisis experienced by Finland, Sweden and Norway in the late 1980s and early 1990s appears to have followed a common pattern. At some point, it became increasingly clear that neither the upward trend in asset prices nor the favourable macroeconomic conditions would last and that much of the recent borrowing had pushed private indebtedness to unsustainable heights. Tax reforms raised real after-tax lending rates and contributed to the sharp drop in property prices. In response, households began to consolidate their financial positions by cutting back on consumption expenditure, and business decreased investment considerably. As a result, all three countries entered a deep recession that in turn accelerated the asset price deflation. In addition, the depreciation of the Norwegian krona in 1986, the Finnish markka in 1991-93 and the Swedish krona in 1992 increased the domestic currency value of debt denominated in foreign currency. Bankruptcy rates reached record levels. The accumulation of losses and repayment difficulties in the highly indebted non-financial sector as well as the decline in collateral values translated into a sharp rise in the financial sector's nonperforming loans leading to banking crisis. In Norway, where the crisis emerged first, banks' loan losses climbed from 0.7 per cent of total loans in 1987 to 6 percent in 1991. Similar, in Finland, loan losses rose from 0.5 percent in 1989 to 4.7 percent in 1992. The surge in loan losses was particularly abrupt in Sweden, where they jumped from 0.3 percent in 1989 to 7 percent in 1992.

[11] A similar boom-and-bust cycle has also been visible in other developed countries, but was particularly pronounced in the Nordic countries (Higgins and Osler (1999)).

According to Lindgren, Garcia and Saal (1996) the banking crises years were: 1991 in Finland, 1987-93 in Norway and 1990-93 in Sweden. Denmark (see below) suffered from significant problems in its banking sector in the period 1987-92. [12] [13]

Developments were particularly similar in Sweden and Finland, even though the boom-bust cycle was more pronounced in Finland.[14] Deregulation in both countries started in the early 1980s. In 1986, the Bank of Finland removed interest rate ceilings on bank lending, and in 1987 corporate long-term borrowing from abroad was completely freed. In Sweden, a first step was taken by the abolition of the liquidity ratios for banks in 1983. This was followed by the removal of interest ceilings in the spring of 1985, and later the same year lending ceilings by banks were lifted. Compounding the initial domestic demand shock in Finland was the collapse of trade with the member countries of the former Soviet Union in 1990-91 and the drop in world market prices for paper and pulp.

The surge in lending in Norway took place somewhat earlier than in Finland and Sweden, reflecting in part differences in the timing of financial liberalisation and macroeconomic conditions. Direct lending controls were abolished in 1984 as part of the general deregulation of banking. In 1986, when the Norwegian economy was hit by declining oil prices, many loans showed signs of poor quality, but lending growth persisted. Losses in the commercial banking sector almost doubled between 1984 and 1986. The problems in the banking sector started to further deteriorate between 1987 and 1989, and in 1991 the banking system collapsed.

The situation in Denmark was rather different compared to the other three Nordic countries. Credit started to expand rapidly in the beginning of the 1980s and credit growth was 32 per cent in 1986, before falling to 10 and 2 per cent in the following two years. One reason for the rapid drop in credit expansion was a tax reform, which reduced the deductibility on interest payments. In contrast to the other Nordic countries, economic growth had been stagnant in the period 1987-93. Certain individual banks had problems during the years 1984-93.

However, the Danish banking sector did not experience a systemic financial crisis like the other three Nordic countries. Due to an earlier and much more gradual deregulation process, the Danish banking sector seemed to have been in a different state of development as problems started to hit the other Nordic countries. Second, the timing in a number of economic policy decisions was better. This concerns particularly the deregulation of financial markets and the introduction of a fixed exchange rate policy.

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[12] For a comprehensive comparison of the banking crises in all Nordic countries, see Möller and Nielsen (1995).

[13] Drees and Pazarbasioglu (1998) surveyed the banking crises in Finland, Sweden and Norway and examined competing hypotheses about the causes of banking problems. A key conclusion was that in addition to business cycle effects, the financial problems in all three countries were exacerbated by delayed policy responses, the structural characteristics of the financial systems, and banks' inadequate internal risk-management controls. Their conclusions indicate that structural changes in the financial sector and in particular credit supply are important for the emergence of financial cycles.

[14] See Englund (1999) for the Swedish case and Brunilla and Takala (1993) and Koskenkylä (2000) for the Finnish case.

The following observations can be made from Figures 1-4. All four Nordic countries went through a complete financial cycle during the 1980s and beginning of the 1990s. Lending, house prices and investment clearly evolved in line with a general cycle. This does not appear to hold for equity prices as the more volatile asset class.

It is not difficult to discern a relationship between the financial cycle, the business cycle and the number of bankruptcies per capita. However, business cycles appear to be shorter than financial cycles. Developments in bankruptcies are clearly more related to the financial cycle than the business cycle. In particular, significant variations in the number of bankruptcies appear to be confined to the period of most pronounced financial imbalances. During that period, the business cycle appears to have peaked first, followed by the financial cycle and finally the number of bankruptcies.

The magnitude of the financial cycle has varied across countries. The sharpest fluctuations appear to have taken place in Finland and the smallest in Denmark. Note also that the degree of synchronisation between the variables appears to be weakest for Denmark and highest for Sweden and Finland.

Average levels of inflation and interest rates appear to be lower for the 1990s than the 1980s due to changes in monetary policy.

The graphs further indicate that the financial cycle reached its peak first in Norway and at about the same time in Sweden and Finland. The timing of the Danish financial cycle is harder to identify due to less synchronized fluctuations of the key variables and appears to be more drawn out in time.

Note that all variables exhibit a high degree of autocorrelation. Lending and share prices in relation to GDP appear to exhibit upwardly sloping trends. This indicates non-stationarity in our data which has to be taken into account in further empirical analysis.

For the 1990s (until 2001, the end of our sample), the question arises if a new financial cycle had emerged. In contrast to the previous cycle, equity markets were particularly strong and property prices more subdued. Lending and investment relative to GDP were far from their historical peaks. In addition, inflation was substantially lower during the 1990s than the 1980s, which indicates more balanced macroeconomic developments and tended to keep down nominal and real interest rates. No clear pattern of the “troublesome threesome” appears thus to have been emerged.

In summary, the following “stylized facts” regarding developments in the “troublesome threesome” and bankruptcies emerge from the graphs. First, the development of a financial cycle in the four Nordic countries during the second half of the 1980s and the beginning of the 1990s is clearly visible in the movement of lending, house prices and investment. Second, developments in bankruptcies are clearly more related to the financial cycle than the business cycle. In particular, variations in the number of bankruptcies are broadly confined to the period of most pronounced financial imbalances. This indicates a strong relationship between macroeconomic imbalances

and financial distress. The financial cycle appears to have peaked before the number of bankruptcies.

In the following sections, the links between the number of bankruptcies and the "troublesome threesome" variables are analyzed by more formal methods, i.e. correlation coefficients in Section 3 and cointegration methods and Granger causality tests in Section 4.

3. Correlations between macroeconomic variables and bankruptcies

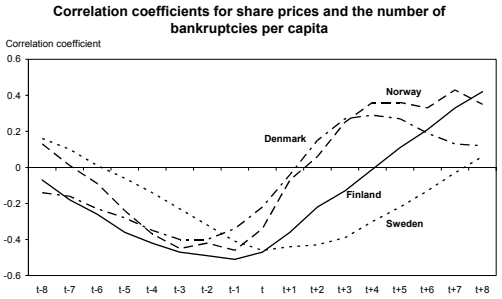
In this section, we present and evaluate leading and lagged correlation coefficients between the number of bankruptcies per capita and our set of relevant macroeconomic variables. The sample ranges from the first quarter of 1982 to the fourth quarter of 2001.

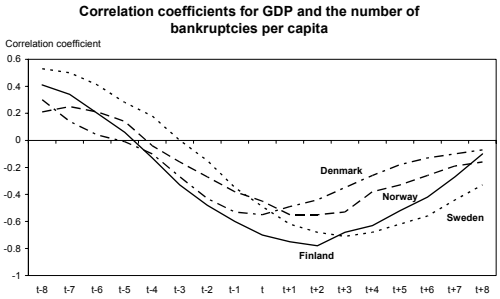
It was concluded in Section 2 that several variables appear to be non-stationary during the sample period,[15] which has to be dealt with in the statistical analysis. The approach in this section is to remove possible trends from the data by a Hodrick-Prescott filter (where the smoothing parameter, as usual for quarterly data, is equal to 1600). By studying cumulative processes (rather than growth rates), we take account of the suggestion that vulnerabilities are created through longer periods of "rapid" growth of the "troublesome threesomes".

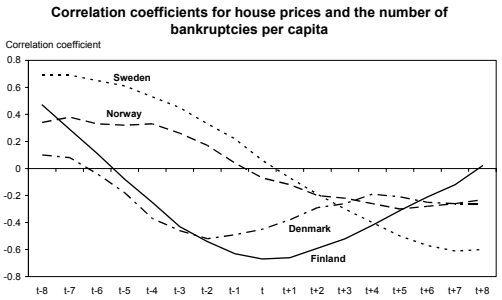
Figure 5 shows leading and lagged correlation coefficients between bankruptcies and the macroeconomic variables. The x-axes denote the number of time lags and leads for the macroeconomic variables in relation to the number of bankruptcies. The maximum number of leads and lags is set to eight.

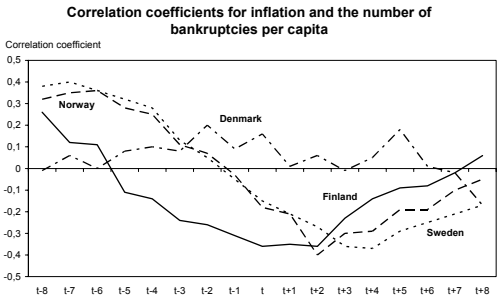
[15] This is confirmed by results of formal unit root tests. These results are not shown here, but are available upon request.

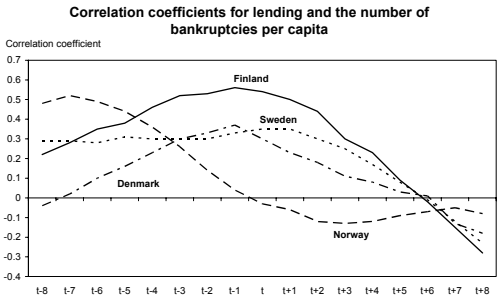
Figure 5: Leading and lagged correlation coefficients for macroeconomic variables and bankruptcies.

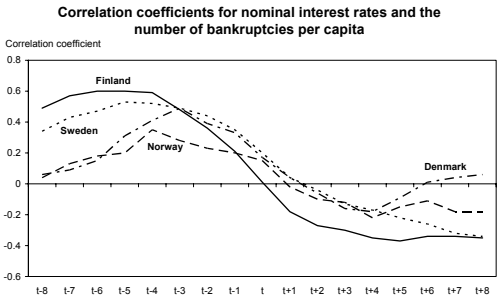


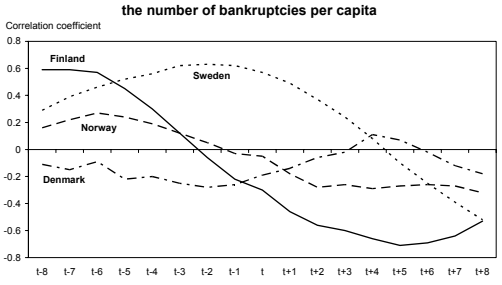


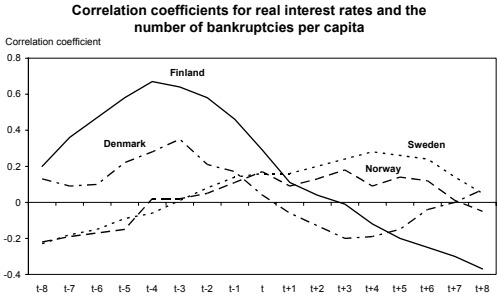


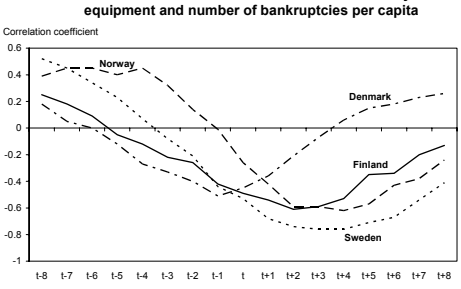












The following "stylized facts" emerge from correlation analysis.

1.) Correlations for lagged credit, asset prices and investment with bankruptcies are generally high. They are highest for house prices among asset prices and for investments in construction among investments. Correlations for share prices and investments in machinery and equipment with bankruptcies are generally lower. This might suggest that developments related to the "troublesome threesome", in particular related to the property market, impact on the number of bankruptcies and financial distress.

2.) Several key relationships appear to be similar for Sweden, Finland and Norway. Patterns for Denmark differ in several cases and the share of insignificant correlations is higher.

3.) Lagged inflation correlates positively with bankruptcies one to two years ahead.

4.) Correlations between lagged nominal interest rates and bankruptcies are positive.

5.) An increase in the number of bankruptcies is typically followed by lower house prices, investment and particularly GDP, but not share prices and credit.

In order to further study the prediction value of the "troublesome threesome" variables for the number of bankruptcies, Granger block exogeneity tests have been carried out for the de-trended data within VAR models including bankruptcies, credit, both types of asset prices and both types of investment. The tests generate mixed results, but indicate that credit and house prices together have predictive power for bankruptcies in Finland, Sweden and Denmark.[16]

4. Cointegration analysis and Granger causality tests

It was concluded in Section 1 that empirical studies on financial cycles and financial distress are complicated by a shortage of theoretical models. In this section we exploit Borio and Lowe's suggestion on the "troublesome threesome" to derive hypotheses on the relationship between credit, asset prices, investment and GDP. As Borio and Lowe's suggestion focuses on cumulative processes or long-run developments, cointegration analysis appears to be the appropriate modelling technique. Cointegration exploits information on long-run developments in the data (in contrast to de-trending data as in Section 3) and identifies long-run equilibrium relationships. In the next step, Granger causality tests are performed within a vector error correction framework to examine if the "troublesome threesome" variables help to predict the number of bankruptcies per capita. [17]

Certain hypotheses based on Borio and Lowe's suggestion can be formulated as restricted or unrestricted linear combinations of credit, asset prices, investment and GDP. Cointegration analysis is then applied to test if a long-run relationship exists, i.e. if cointegration between the involved variables is supported. If cointegration is found

[16] Results are available upon request from the author.
[17] Cointegration analysis and Granger causality tests have been performed using Anders Warne's MatLab-based program for structural VAR models *(www.warne.texlips.org)*.

(or rather, not rejected) for the ratio of credit to GDP, for example, a faster rise in credit than GDP for longer periods will not be sustainable and sooner or later will lead to a reversal, with credit rising slower than GDP. The same line of reasoning holds for asset prices and investment as well as combinations of the "troublesome threesome" variables.

The applied methodology in this study is the multivariate approach to cointegration analysis proposed by Johansen.[18] The Johansen approach is preferred to alternative single equation estimators because multiple long-run relationships might exist, and there is no a priori reason to assume that any variable is weakly exogenous. Under these circumstances, single equation techniques yield inefficient coefficient estimates.

The cointegration analysis is based on the VAR model:

$$A(L)x_t = Bc_t + u_t,$$

where $A(L)$ is a matrix for the lagoperator L, x_t is a vector of endogenous variables, B is a matrix with parameters, c_t is a vector of deterministic variables and u is a vector of error terms.

The Johansen methodology is based on maximum likelihood estimation, so that Gausian error terms are required. The lag-order of the VARs is therefore chosen in order to obtain well behaved VAR residuals. The VAR model can be reformulated in vector error-correction form:

$$\Delta x_t = \Pi x_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta x_{t-i} + Bc_t + u_t.$$

The cointegration test is based on the rank of the matrix Π, which indicates the number of long-run relationships between the endogenous variables in the VAR. The following analysis is based on the trace test. Based on the number of long-run relationships indicated by the cointegration test, the matrix Π can be factorised as $\Pi = \alpha\beta'$, where α is a $n \times r$ matrix of loading or adjustment coefficients and β is an $n \times r$ matrix of cointegrating vectors, with n equal to the number of endogenous variables and r equal to the number of long-run relationships in the system. The cointegrating vectors forming the matrix β describe the relationships linking the endogenous variables in the long run. The loading coefficients forming the matrix α describe the dynamic adjustment of the endogenous variables to deviations from long-run equilibrium by $\beta' x$.

It would be preferable to carry out hypothesis tests within established empirical models, for example a typical monetary policy model comprised of output, prices and the central bank rate, extended by the "troublesome threesome" variables and bankruptcies.[19] This would allow us to explicitly take account of and study interactions between macroeconomic imbalances, financial distress, price stability and monetary

[18] See t.ex. Hamilton (1994).
[19] See Svensson (1999) and Bergman and Hansen (2002).

policy. However, due to the limited number of observations in our sample, the estimations have been carried out within a smaller model consisting of GDP, the "troublesome threesome" variables and the number of bankruptcies.

The empirical results in Section 3 indicate that bankruptcies have the strongest relationship with house prices among asset prices and with investment in construction among investment. We therefore select credit, house prices and investment in construction as candidates for the "troublesome threesome".[20] All variables are expressed as logs, and lending and house prices have been deflated by the consumer price index. Table 1 lists the variables in the model.

Table 1: Variables in the selected model

Variable	Coefficient in the cointegrating vector
GDP (constant prices)	β_1
Number of bankruptcies per capita	β_2
Lending to the private sector (constant prices)	β_3
House prices (constant prices)	β_4
Investment in construction (constant prices)	β_5

Table B1 in Appendix B reports the preferred lag-order and some diagnostics for the VAR models, i.e. information criteria (Hannon-Quinn), and tests for residual autocorrelation, non-normality and heteroskedasticity. The specification tests suggest that residual correlation and heteroskedasticity are largely absent for all countries. For Norway and in particular Denmark, evidence of non-normality is found.[21] Closer examination reveals that non-normality is mainly explained by outliers or kurtosis ("fat tails"), rather than skewness of the residual distribution, which would be stronger evidence for model misspecification.[22] All in all it is concluded that the models are broadly accepted by the data.

Table B2 in Appendix B reports the estimation results for the cointegration tests.[23] The trace test suggests the existence of one long-run relationship for all four countries. This finding indicates that at least two of the "troublesome threesome" variables did not evolve in line with GDP during the sample period. This result is clearly in line with Borio and Lowe's suggestion that different growth rates for individual "troublesome threesome" variables relative to GDP need not be unsustainable in the long run and lead to financial distress. Credit, house prices and investment in construction might rather be driven by independent stochastic trends.

[20] We have also carried out cointegration analysis for alternative models. First, we have estimated various models including share (instead of house) prices and investment in machinery and equipment (instead of investment in construction). Tentative results have been discouraging, i.e. estimations have not revealed reasonable or theoretically interpretable long-run relationships. Second, we have estimated an "augmented" monetary policy model, described above, including lending, house prices and investment in construction. Qualitative results are in line with those of the smaller model, arguing for some robustness.

[21] This might be interpreted as further evidence that Denmark is "special".

[22] This conclusion appears to be valid also for Denmark where the hypothesis of non-skewness is rejected for just one of five equations.

[23] The constant is left unrestricted, allowing for deterministic time trends in the levels of the data.

The long-run development of credit, for example, might be affected by trends in the efficiency of financial markets or, more specifically, debtor's capacity to hold debt. The identification of stochastic trends requires more developed models on financial cycles and financial distress and is not further pursued in this paper. [24]

Next, we try to identify the cointegration vector by testing different hypotheses based on the suggestion of Borio and Lowe. The cointegration relationships consist of GDP and different combinations of credit, house prices and investment in construction. Table 2 provides details on the restrictions. Column 2 reports the variables included in the cointegration vector. The order of variables in the models corresponds to Table 1. Column 3 lists the coefficient restrictions in vector form where "x" denotes a free parameter. Columns 4 and 5 further explain the cointegration hypotheses.

Table 2: Details on selected cointegration hypotheses

Hypothesis	**Variables in the cointegration vector**	**Restrictions on the cointegration vector** $[\beta_1, \beta_2, \beta_3, \beta_4, \beta_5]$	**Interpretation of hypothesis for variables in levels**	**Interpretation of hypothesis for variables in growth rates**
1	GDP, lending, house prices, investment in construction	[1,0,x,x,x]	Unrestricted log-linear combination of credit, house prices, investment and GDP	Unrestricted growth rates
2	GDP, lending, house prices, investment in construction	[1,0,x,x,x], where $\beta_1 = -(\beta_3 + \beta_4 + \beta_5)$	Constant ratio of weighted sum of credit, house prices and investment to GDP	Equal growth rates of weighted sum of credit, house prices and investment relative GDP
3	GDP, lending, house prices	[1,0,x,x,0], where $\beta_1 = -(\beta_3 + \beta_4)$	Constant ratio of weighted sum of credit and house prices to GDP	Equal growth rates of weighted sum of credit and house prices relative GDP

Hypothesis 1 states an unrestricted linear combination of the "troublesome threesome" and GDP, i.e. it is not required that the "troublesome threesome" jointly are constant as a share of GDP. Hypothesis 1 is not directly linked to Borio and Lowe's suggestion.

Hypothesis 2 states that a linear combination of the "troublesome threesome" variables is constant as a share of GDP. If the coefficient signs are found to be negative (while

[24] Note, however, that the sample length might be too short to properly study the time series properties of our variables as it includes a period of structural changes in financial markets. Temporary trends and shifting mean values can easily create the impression of or generate non-stationary behaviour in short samples. The finding of different stochastic trends for individual "troublesome threesome" variables and GDP must therefore be interpreted with caution.

restricted to 1 for GDP), an increase in all "troublesome threesome" variables relative to GDP contributes to the build-up of macroeconomic imbalances. In addition, changes in one variable's ratio to GDP does not necessarily imply a reversal even in the long run if it is counteracted or mitigated by an opposite change in another variable relative to GDP. It is only if the combined or "net effect" of all "troublesome threesome" variables is rising relative to GDP that their joint path is supposed to become unsustainable. Hypothesis 3 corresponds to hypothesis 2, but refers instead to the "troublesome two" by excluding investment in construction. [25]

The various hypotheses are formally derived in Appendix C.

Column 2 in Tables 3-6 reports coefficient estimates and t-values for the variables in the cointegration relationships. The coefficient for GDP is normalised to 1. Column 3 reports p-values for the LR test for binding restrictions implied by the hypothesis under consideration.

Table 3: Cointegration tests for Finland

Hypothesis	**Coefficients** *(t-value)*			**LR test for binding restrictions (p-value)**
	β_3	β_4	β_5	
1	0.95	-2.45	1.37	0.19
	(6.75)	*(-9.65)*	*(4.23)*	
2	1.08	-2.62	0.54	0.03
	(5.84)	*(-7.84)*	*(2.13)*	
3	0.85	-1.85	—	0.02
	(5.40)	*(-11.77)*		

Table 4: Cointegration tests for Norway

Hypothesis	**Coefficients** *(t-value)*			**LR test for binding restrictions (p-value)**
	β_3	β_4	β_5	
1	-0.17	-0.79	0.46	0.14
	(-3.31)	*(-5.90)*	*(1.96)*	
2	-0.06	-1.05	0.11	0.18
	(-0.91)	*(-5.61)*	*(0.60)*	
3	-0.09	-0.91	—	0.32
	(-1.49)	*(-14.66)*		

[25] Note that regressions 2 and 3 are approximations of Borio and Lowe's hypothesis which defines an unsustainable development as a path where all "troublesome threesome" variables simultaneously increase "rapidly" or are above their long-run equilibrium, not just their combined effect.

Table 5: Cointegration tests for Denmark

Hypothesis	**Coefficients** *(t-value)*			**LR test for binding restrictions (p -value)**
	β_3	β_4	β_5	
1	-0.09	-0.51	0.29	0.26
	(-4.24)	*(-13.89)*	*(14.52)*	
2	-0.09	-0.88	-0.03	0.00
	(-1.16)	*(-7.13)*	*(-0.45)*	
3	-0.06	-0.94	—	0.00
	(-0.77)	*(-12.78)*		

Table 6: Cointegration tests for Sweden

Hypothesis	**Coefficients** *(t-value)*			**LR test for binding restrictions (p -value)**
	β_3	β_4	β_5	
1	-2.42	3.68	0.70	0.63
	(-5.15)	*(4.31)*	*(3.71)*	
2	0.52	-1.50	-0.02	0.40
	(3.06)	*(-7.74)*	*(-0.27)*	
3	0.49	-1.49	—	0.60
	(3.04)	*(-9.28)*		

Note, that the data sample presumably spans over no more than one and a half financial cycles and includes a period of structural changes in the financial sector. This argues for applying a rather low significance level in the cointegration tests. p - values of at least 1 per cent are therefore regarded as (some) support for cointegration.

Tables 3-6 show that cointegration for the "troublesome threesome" and GDP is clearly supported for Sweden and Norway and to a lesser extent for Finland and Denmark. For Denmark, cointegration is only supported for the unrestricted cointegration relationship according to Hypothesis 1. For Finland, cointegration is clearly supported for Hypothesis 1 and at low p -values also for Hypotheses 2 and 3 . For Norway and Sweden, cointegration is strongly supported for all three hypotheses with high p - values.

Further interpretation of the results for Hypotheses 2 and 3 in light of Borio and Lowe's suggestion requires closer inspection of the estimated coefficients. Several "wrong" (positive) coefficient signs emerge from the estimations. In particular, estimated coefficients for house prices tend to be relatively large and "right-signed". Estimated coefficients for lending are substantially smaller and "wrong-signed" for Finland and Sweden. Coefficients for investment in construction are "wrong-signed" in most cases. Positive coefficient signs for individual "troublesome threesome" variables imply that a higher growth rate than GDP contributes to smaller rather than larger macroeconomic imbalances. This is clearly counterintuitive and contradicts Borio and Lowe's suggestion.

However, the finding of "wrong" signs should not be overstated. It was concluded in Section 2 that correlations between the "troublesome threesome" variables, in particular between credit and house prices, are high. This might create problems with multicollinearity, i.e. the explanatory power of single variables cannot be separated from each other. Thus, coefficient estimates and significance levels need to be interpreted with caution. House prices, for example, might "steal" explanatory power from lending. Note that the sum of coefficient estimates is "right-signed" even for Finland and Sweden due to larger coefficient estimates for house prices. The main conclusion of finding "wrong" signs is probably that it is desirable to impose and test additional coefficient restrictions. However, due to the rather vague theoretical underpinning of financial cycles, additional restrictions are not straightforward to identify and their derivation is left to further research.

We have also carried out bivariate cointegration tests for individual variables among the "troublesome threesome" and GDP (see the discussion on potential long-run relationships on pages 16-17). p-values are generally found to be lower and cointegration is rejected in several cases.

It is evident from Tables 3-6 that house prices exhibit by far the largest coefficients and t-values in the cointegrating vectors. This result might indicate that house prices play the most important role in the emergence of financial imbalances. Investment in construction, on the contrary, is most often "wrong"- signed and tends to be insignificant in Hypothesis 2 which argues for dropping it altogether from the cointegrating vector. Thus, the estimations indicate the existence of the "troublesome twosome" rather than the "troublesome threesome". This is in line with findings in Borio and Lowe (2002). Note, however, that this result has to be interpreted very cautiously due to the potential problem of multicollinearity mentioned above.

In summary, the cointegration analysis indicates that it is the joint path rather than the individual paths of the "troublesome threesome" variables relative to GDP that forms a long-run equilibrium. Unsustainable developments, or macroeconomic imbalances, arise if the "troublesome threesome" variables jointly rise faster than GDP. However, "wrong" coefficient signs for individual "troublesome threesome" variables complicate further structural interpretations of the results and increase the desirability to impose further coefficient restrictions. All in all, the estimation results may lend some limited support for Borio and Lowe's suggestions on the "troublesome threesome". The model in Hypothesis 3 consisting of credit and house prices is selected as the preferred one for further analysis. [26]

In the next step, we test by means of Granger causality tests if the "troublesome threesome" variables help to predict bankruptcies in the corresponding VEC models. According to Borio and Lowe, periods of credit and house prices jointly above their long-run equilibrium should be related to increasing financial distress or a rising number of bankruptcies.

Recall the formulation of the general VEC model

[26] In order to simplify the presentation and not focus too much on a single model, we continue in general to speak about the "troublesome threesome".

$$\Delta x_t = \Pi x_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta x_{t-i} + Bc_t + u_t,$$

where $\Pi = \alpha\beta'$.

The following three Granger causality tests were carried out:

1. $H_0: \alpha = 0$ (weak exogeneity)

If the loading or adjustment coefficient is found to be insignificant, the cointegration relationship does not help to predict (or does not "Granger cause") bankruptcies. Bankruptcies are then said to be "weakly exogenous". The hypothesis that deviations of the "troublesome threesome" variables from their estimated long-run equilibrium relationship impact on bankruptcies is then rejected. Results from these tests are shown in column 2 in Table 7.

2. $H_0: \alpha$ and $\Gamma_i = 0$, where i refers to all variables that are included in the cointegration relationship (joint short- and long-run causality)

If both the loading and the dynamics of the variables in the cointegration relationship are found to be insignificant, the variables in the cointegration relationship do not help to predict bankruptcies neither in the short nor in the long run. The hypothesis stating that the variables in the cointegration relationship impact on bankruptcies is then rejected. Results from these tests are shown in column 3 in Table 7.

The Granger causality tests 1 and 2 test for the joint impact of the "troublesome threesome" variables on financial instability.

3. $H_0: \Pi_i = \alpha\beta_i' = 0$ and $\Gamma_i = 0$, where i refers a single "troublesome threesome" variable in the cointegration relationship (short- and long-run causality)

If a certain variable is found to be insignificant in both the long- and short-run part of the VEC model, this variable does not help to predict bankruptcies. Results from these tests are shown in column 4 and 5 of Table 7.

Table 7 shows results of these 3 different Granger causality tests for the preferred VEC model according to Hypothesis 3. p-values of at most 10 per cent are regarded as support for Granger causality.

Table 7: Granger causality tests for the preferred model (Hypothesis 3)

Country	**Test 1: Weak exogenity (p - value)**	**Test 2: Joint short- and long-run causality (p -value)**	**Test 3: Short- and long-run causality (p -value)**	
			β_3	β_4
Finland	0.02	0.00	0.00	0.01
Norway	0.00	0.02	0.01	0.00
Denmark	0.15	0.01	0.02	0.13
Sweden	0.00	0.00	0.00	0.00

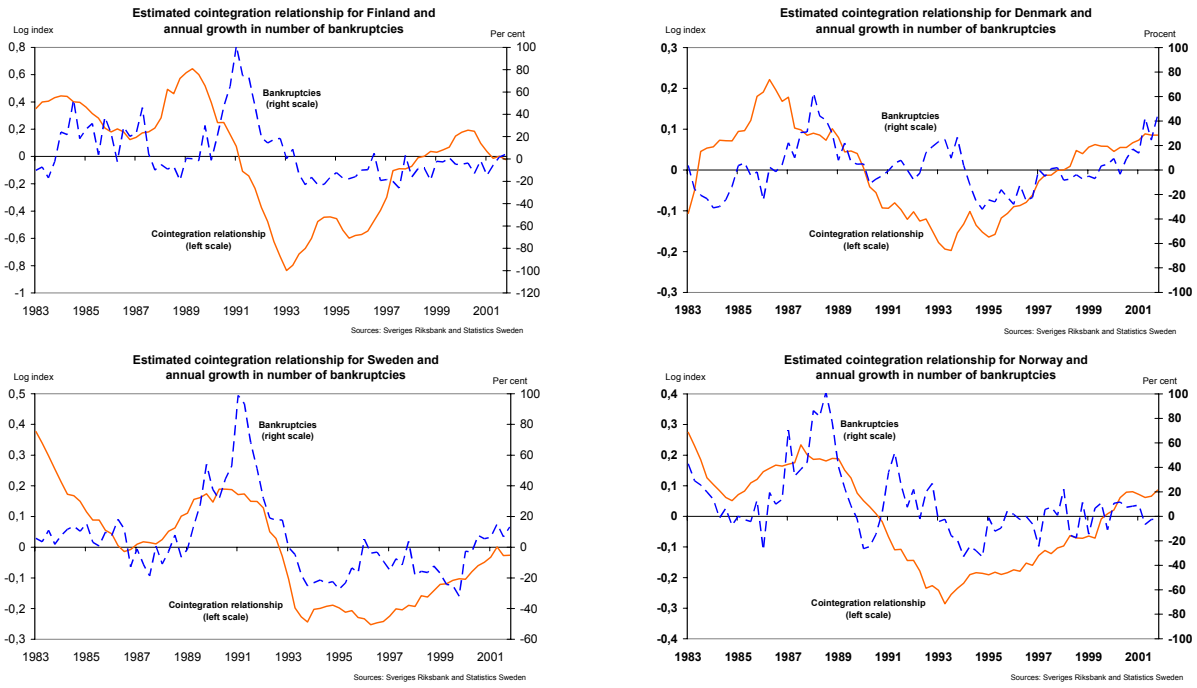
In general, these Granger causality tests indicate very high predictive power of lending and house prices for bankruptcies. This concerns both long-run and combined long- and short-run causality tests for the joint and single impact of the "troublesome twosome" variables on bankruptcies. The notable exception is Denmark, where weak exogenity is not rejected and house prices individually are not significant at the 10 per cent level. This might be regarded as further evidence that Denmark is "special" among the four countries. [27]

Granger tests indicate stronger impact of the "troublesome threesome" variables on bankruptcies for models estimated in levels using cointegration techniques than for models applying de-trended variables (see p. 14). This, together with results from weak exogenity tests, suggests that long-run developments of the "troublesome threesome" variables in relation to GDP have important implications on the number of bankruptcies.

Figure 6 shows the estimated cointegration relationships for the preferred model and annual growth rates of the number of bankruptcies for the four Nordic countries. Correlations are generally high. According to these estimations, imbalances were largest in Finland at the end of the 1980s and the beginning of the 1990s and at about the same size in Denmark, Sweden and Norway. The estimations further indicate that imbalances were small at the end of 2001 in all four countries.

[27] Corresponding Granger causality tests for the models according to Hypotheses 1 and 2 yield very similar results. In particular, results for Denmark are somewhat more mixed than for the other three countries and investment in construction is insignificant in two of the four countries. The last finding argues further for the existence of the "troublesome twosome" rather than the "troublesome threesome".

Figure 6: Estimated cointegration relationships for the preferred model (Hypothesis 3) and annual growth rate of the number of bankruptcies



5. Conclusions

This paper studies the empirical relationships between financial cycles, i.e. movements in credit, asset prises and investment, and bankruptcies (or financial distress in a wider sense) in the Nordic countries. The point of departure is Borio and Lowe's suggestion that risks for financial instability increase substantially if rapid growth of lending, asset prices and possibly investment, or the "troublesome threesome", occurs simultaneously.

Inspection of time series plots indicates a strong relationship between macroeconomic imbalances and bankruptcies. Leading and lagged correlation coefficients on de-trended data between credit, asset prices and investment and bankruptcies are generally high. They are highest for house prices among asset prices and investments in construction among investments.

On the basis of Borio and Lowe's suggestion, the main part of the paper derives hypotheses on relationships between credit, house prices, investment in construction and GDP, and tests them by means of cointegration techniques.

Results from the cointegration analysis suggest that linear combinations of the "troublesome threesome" form cointegration relationships with GDP. This supports Borio and Lowe's suggestion that the joint path, rather than the individual paths of the "troublesome threesome" relative to GDP creates macroeconomic imbalances. The cointegration analysis indicates that unsustainable developments, or macroeconomic imbalances, arise if the "troublesome threesome" variables jointly increase faster than GDP. However, "wrong" coefficient signs for individual "troublesome threesome" variables emerge and complicate structural interpretations of the results. This

increases the desirability to impose and test additional coefficient restrictions. All in all, the results from the cointegration analysis lend some support to Borio and Lowe's suggestions on the "troublesome threesome".

Granger causality tests indicate a very high predictive power of lending and house prices for bankruptcies. In particular, long-run developments of the "troublesome threesome" relative to GDP appear to have important implications for the number of bankruptcies.

The results indicate that house prices play the most important role in the build-up of financial imbalances among the "troublesome threesome". On the other hand, investment in construction neither appears to significantly contribute to financial imbalances nor helps to predict bankruptcies. This finding argues for the existence of the "troublesome twosome" rather than the "troublesome threesome".

Several empirical results appear to be similar for Sweden, Finland and Norway, while patterns for Denmark often differ. This is in line with the conclusion in Section 2 that financial deregulation and economic policy, as well as subsequent macroeconomic and financial developments, were different in Denmark. Finally, the estimations indicate that macroeconomic imbalances were small at the end of 2001 in all four countries.

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Appendix A: Data Sources

Variable	Finland	Sweden	Denmark	Norway
GDP (current prices)	OECD (MEI)	Statistics Sweden and Sveriges Riksbank	OECD (MEI)*	Hanson and Partners AB***
GDP (constant prices)	OECD (MEI)	Statistics Sweden and Sveriges Riksbank	OECD (MEI)*	Hanson and Partners AB***
Investment in machinery and equipment (current prices)	Hanson and Partners AB	Statistics Sweden	Statistics Denmark*	Hanson and Partners AB***
Investments in machinery and equipment (constant prices)	OECD (MEI)	Statistics Sweden	OECD (MEI)*	OECD (MEI)***
Investments in construction (current prices)	Hanson and Partners AB	Statistics Sweden	Not available	Hanson and Partners AB***
Investments in construction (constant prices)	OECD (MEI)	Statistics Sweden	OECD (MEI)**	OECD (MEI)***
CPI	OECD (MEI)	Statistics Sweden	OECD (MEI)	OECD (MEI)
Lending	IFS: Banking survey. Claims (of all credit institutions) on other resident sectors.	Sveriges Riksbank: Lending from all credit institutions to general public.	IFS: Deposit money banks. Claims on other resident sectors. Since 1999 Hanson and Partners AB: Banks domestic lending, private sector.	IFS: Deposit money banks. Claims on private sectors.
Treasury bill rate (3-month)	Hanson and Partners AB	Hanson and Partners AB	Hanson and Partners AB	Hanson and Partners AB
(Broad) share price index	Hanson and Partners AB	Hanson and Partners AB	Hanson and Partners AB	Hanson and Partners AB
Residential house prices	Bank of Finland (Greater Helsinki)	Statistics Sweden	Bank of Denmark	Bank of Norway
Number of bankruptcies	Bank of Finland (Corporate and private bankruptcies)	Statistics Sweden (corporate bankruptcies)	Bank of Denmark (corporate and private bankruptcies)	Bank of Norway (corporate and private bankruptcies)
Population number	IMF (IFS)	IMF (IFS)	IMF (IFS)	IMF (IFS)

* Prior to 1988 interpolated annual data from Statistics Denmark.
** Construction dwellings started, seasonally-adjusted.
*** Refers to mainland economy.

Appendix B

This appendix reports results of cointegration analysis and diagnostic tests for the VAR and VEC models (according to hypothesis 3).

Table B1: Diagnostic tests for the VAR model

Country	VAR Lag Order Selection Criteria (Hannan Quinn)	LM Test Autocorrelation (p -value)			Normality Test (Orthogonalization Cholesky (Luetkepohl)) (p -value)			White Heteroskedasticity Test (no cross terms) (p -value)
		Lag 1	Lag 2	Lag 3	Skewness	Kurtosis	Joint	
Finland (3 lags)	1	0.04	0.37	0.19	0.94	0.02	0.13	0.41
Sweden (2 lags)	1	0.52	0.74	0.13	0.52	0.09	0.18	0.54
Denmark (2 lags)	1	0.27	0.18	0.10	0.00	0.00	0.00	0.06
Norway (2 lags)	1	0.31	0.43	0.24	0.05	0.04	0.01	0.30

Table B2: Cointegration analysis

Rank	95% Quantile	Trace test			
		Finland	Sweden	Denmark	Norway
0	69.82	77.36	73.58	75.29	81.91
1	47.86	42.34	44.51	42.21	41.85
2	29.80	16.29	23.46	18.33	18.43
3	15.50	6.54	12.49	4.70	7.88
4	3.84	0.36	3.48	0.01	2.71

Table B3: Diagnostic tests for the VEC model (Hypothesis 3)

Country	LM Test Autocorrelation (p -value)			Normality Test (Orthogonalization Cholesky (Luetkepohl)) (p -value)			White Heteroskedasticity Test (no cross terms) (p -value)
	Lag 1	Lag 2	Lag 3	Skewness	Kurtosis	Joint	
Finland	0.04	0.06	0.33	0.98	0.19	0.60	0.08
Sweden	0.43	0.68	0.11	0.55	0.83	0.80	0.70
Denmark	0.48	0.22	0.00	0.00	0.00	0.00	0.67
Norway	0.11	0.13	0.27	0.00	0.00	0.00	0.87

Appendix C

Here, the cointegration hypotheses of Section 4 are formally derived. We apply exponential functions in order to consider percentage (rather than absolute) changes in the variables.

Hypothesis 1 tests whether an unrestricted linear combination of credit, house prices, investment in construction and GDP is stationary. This can be expressed by the following equation

$$\frac{VAR_1^{\,x}}{GDP} \quad \frac{VAR_2^{\,y}}{GDP} \quad \frac{VAR_3^{\,z}}{GDP} \quad = \quad e^{\mu},$$

where VAR(1 to 3) are the "troublesome threesome" variables, x, y and z are parameters and μ is a constant.

Taking logs, we arrive at

$$x\ln(VAR_1) - \ln(GDP) \quad + \quad y\ln(VAR_2) - \ln(GDP) \quad + \quad z\ln(VAR_3) - \ln(GDP) \quad = \quad e^{\mu},$$

$$x\ln(VAR_1) \quad + \quad y\ln(VAR_2) \quad + \quad z\ln(VAR_3) \quad - \quad 3\ln(GDP) \quad = \quad \mu,$$

or after normalisation

$$\frac{x}{3}\ln(VAR_1) \quad + \quad \frac{y}{3}\ln(VAR_2) \quad + \quad \frac{z}{3}\ln(VAR_3) \quad - \quad \ln(GDP) \quad = \quad \mu.$$

Because the parameters x, y and z are unrestricted, the weighted sum of the "troublesome threesome" variables relative to GDP does not need to be constant.

Hypotheses 2 and 3 test whether linear combinations of the "troublesome threesome" variables are constant as a share of GDP:

$$\left(\frac{VAR_1}{GDP}\right)^a \quad \left(\frac{VAR_2}{GDP}\right)^b \quad \left(\frac{VAR_3}{GDP}\right)^c \quad = \quad e^{\mu},$$

where VAR(1 to 3) are the "troublesome threesome" variables, a, b, c are parameters and μ is a constant. The parameters a, b and c express the weights for the respective "troublesome threesome" variable relative to GDP.

Taking logs, we arrive at

$$a(\ln(VAR_1) - \ln(GDP)) \quad + \quad b(\ln(VAR_2) - \ln(GDP)) + c(\ln(VAR_3) - \ln(GDP)) \quad = \quad \mu.$$

Rearranging yields

$$a(\ln(VAR_1) \quad + \quad b(\ln(VAR_2) \quad + \quad c(\ln(VAR_3) - \quad (a+b+c)\ln(GDP)) \quad = \quad \mu,$$

or after normalisation

$$\frac{a}{a+b+c}(\ln(VAR_1) \quad + \quad \frac{b}{a+b+c}(\ln(VAR_2) \quad + \quad \frac{c}{a+b+c}(\ln(VAR_3) - \quad \ln(GDP)) \quad = \quad \mu .$$

Because the weights sum up to unity, the weighted sum of the "troublesome threesome" variables relative to GDP is constant.

Hypothesis 3 corresponds to Hypothesis 2 excluding VAR(3).

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