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Financial Instability and Monetary Policy: The Swedish Evidence*

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Abstract

This paper examines the relationship between financial instability and monetary policy within the Swedish economy. Based on a standard VAR model of monetary policy extended to include measures of financial instability and credit expansions, we examine the interaction between monetary policy and financial stability. We find that both higher interest rates, higher prices and lending expansions contribute to financial instability. As the effects from price shocks are strong and persistent compared to other shocks, our conclusion is that we cannot reject that price stability and financial stability are mutually consistent goals for monetary policy.
JEL Classification: C12, C22

Keywords: Financial instability; monetary policy; VAR model; structural shocks.

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1 Introduction

The primary goal of monetary policy in several OECD countries is to maintain stable prices or low and stable inflation. This policy has largely been successful in bringing inflation in the major OECD countries under control. However, there also appears to have been an increase in financial instability during the last 30 years among both developing and developed countries.[1] Several countries, including the United States, Sweden and Finland, have experienced financial crises or recessions often attributed to sharp declines in asset prices and problems in the banking sector, see, e.g., Borio, Kennedy and Prowse (1994), Bank for International Settlements (1998) and International Monetary Fund (2000).

There is an ongoing debate among policymakers and economists on the objectives of monetary policy, in particular whether and particularly how monetary policy should respond to increases in financial instability, see, e.g., Svensson (1996), Taylor (1996), Bean (1998), and Goodfriend (2001). Price stability and financial stability are viewed by Bernanke and Gertler (1999) as complementary and mutually consistent objectives of monetary policy. This argument is based on the notion that price stability tends to produce stable macroeconomic conditions and that higher inflation and surging asset prices are both counteracted by higher interest rates.

It may, however, be the case that price stability and financial stability are conflicting goals of monetary policy as economic theory suggests that both price shocks and interest rate shocks are two fundamental forces that produce financial distress, see Fisher (1933), Stiglitz and Weiss (1981), Bernanke and Gertler (1989), Mishkin (1998), and Allen and Gale (1999, 2000).

The relation between price and financial stability also depends on how financial stability is defined, which is far more complicated than to define price stability. To start with, systemic financial crises may be viewed as potentially severe disruptions of financial markets that, by impairing markets ability to function effectively, can have large adverse effects on the real economy. Banking crises have traditionally been considered the greatest threat to the functioning of the financial system, as banks' operations are important to all of the main functions of the financial system. Therefore, financial stability in general is often defined as a situation with absence or little risk of banking crises. This has sometimes led both theoretical and empirical studies to regard financial stability as a binary variable which assigns a value of one to periods of crises and zero otherwise.

However, in a wider sense financial risks depend on the structure of the financial system.

[1] IMF (1998) for example identifies 54 banking crises between 1975–97 for a group of 22 industrial countries and 31 developing countries. Banking crises were found to be somewhat more prevalent in the second half of the sample period, reflecting an increased incidence since the early 1980s, possibly related to financial sector liberalization that occurred in many countries during this period.

The financial system is strongly integrated, which means that stability problems arising in one part of the system rapidly spread to other parts. The increasing importance of security markets, for example, has put more emphasize on price bubbles.[2] Thus, the term financial instability is sometimes used to describe a variety of disruptions in financial markets as sharp declines in asset prices, failures in the non-bank financial sector, such as the commercial paper market, failures of large non–financial firms, disruptions in foreign exchange markets or some combinations of these. The common feature of all these financial disturbances is that they to a varying degree may impair the functioning of the financial system and hence developments in the real economy. Financial stability in this perspective is viewed as different degrees of financial distress and corresponding repercussions to the real economy. This view on financial stability is applied in our study. In order to avoid confusion with the "crises–none crises" view we use the term financial distress to describe different degrees of financial instability.[3]

Researchers have over the years developed a variety of economic theories to explain financial distress. According to Fisher (1933), financial distress is directly related to macroeconomic developments. Business cycle upturns and high and volatile inflation tend to encourage overly optimistic forecasts of real returns and (speculative) investment and thus can lead to lending booms.[4] The process continues until a general state of overindebtness is reached or the economy is hit by a major macroeconomic shock. The inability of borrowers to repay their debts leads to distress selling, falling asset prices, lower aggregate demand, disinflation or even deflation. Deflation may lead to excessively pessimistic forecasts, increasing real interest rates, leading to further bankruptcies, nonperforming assets and loan losses and declining economic activity, a process referred to as debt–deflation. As bank's profitability and solidity deteriorate, lending policy is tightened, which in turn has a negative feedback effect on the economy.

More recent work on financial distress is often based on the seminal paper by Stiglitz and Weiss (1981) who suggested that imperfect information can give rise to credit rationing, see for example Bernanke and Gertler (1989), Mishkin (1994, 1998) and Allen and Gale (1999, 2000). Situations with asymmetric information are characterized by adverse selection as borrowers with the biggest risks are most likely to wish to borrow money, and moral hazard

[2]See Daltung (2001).

[3]It is important to note that this view clearly questions the separation of financial and output stability as different monetary policy objectives. The issue of financial stability may rather be considered as an additional channel of the monetary transmission mechanism. The effect of a credit crunch on the real economy for example is then mainly regarded as the credit channel of monetary policy rather than a loss of financial stability.

[4]The relation between inflation and financial distress is well in line with Lucas' monetary missperception model, see Bordo and Wheelock (1998).

as debt can encourage the borrower to undertake more risky projects. Higher real interest rates are one indicator of greater asymmetric information because they increase both the adverse selection and moral hazard problem in the credit market.[5]

Even though the literature proposes different transmission mechanisms, they in general agree on the important role played by credit expansions, price shocks and interest rate shocks for explaining increases in financial distress. These predictions are also in large supported by the empirical evidence. In a comprehensive survey of the empirical literature, Bell and Pain (2001) list high real interest rates, high inflation and rapid credit growth, amongst other indicators, as important leading indicators of banking crises. Empirical studies on financial distress typically focuses on finding leading indicators of banking crises without explicitly conditioning on economic policy, see the survey by Bell and Pain (2000).

In this paper, we examine how price, interest rate and credit shocks affect financial distress in the Swedish economy. In this context, we also investigate whether price stability and avoidance of financial distress are mutually consistent goals for monetary policy. Our empirical methodology is based on a standard empirical model describing monetary policy (a trivariate vector autoregressive (VAR) model comprised of output, prices and an interest rate) extended to include measures of the degree of financial distress.[6] We construct a continuous time series of financial instability following Bordo, Dueker and Wheelock (2000, 2001). These measures include both bankruptcies and the excess return from housing reflecting the vulnerability of the banking sector. We also extend our model by including lending to the non–bank sector serving as a proxy for credit expansions.[7] Our paper contributes to the earlier literature by explicitly taking into account the linkages between financial distress and monetary policy allowing us to examine the sources of financial distress and how these sources interact with monetary policy.

We find that positive shocks to the price level, the interest rate and bank lending to the non–bank sector lead to increased financial distress. Price shocks exert a stronger impact on financial distress than monetary policy shocks. Lending shocks affect financial distress with a time lag of 2 to 3 years.

The paper is organized in the following way. Section 2 contains a discussion of our empirical model including identification of the structural model and Granger noncausality

[5]Higher interest rates may also lead to increasing financial instability through its effects on firms', household's and bank's balance sheets as it tends to reduce the cash flow and net worth, see Bernanke and Gertler (1995) and Mishkin (1998).

[6]The theoretical underpinning of this trivariate VAR model is discussed by Svensson (1997, 2000a, 2000b). Christiano, Eichenbaum och Evans (1998) survey the empirical literature studying monetary policy using vector autoregressive models.

[7]Allen and Gale (2000) suggest that credit expansions play an important role in explaining financial crisis since an increase in the supply of credit leads to more excessive risk taking.

tests within the reduced form model. In section 3 we report the results from our empirical study. Finally, section 5 summarizes our main results.

2 Methodology and empirical model

The starting point of our empirical study is the standard trivariate vector autoregression (VAR) model comprised of output, y, prices, p, and the central bank rate, r, used to examine the effects of monetary policy.[8] The underlying theoretical model consists of three equations, one IS equation, a Phillips curve and a Taylor rule (Svensson (1997,2000a,2000b), Rudebusch och Svensson (1999)). This model predicts that the transmission of monetary policy is delayed such that monetary policy cannot affect output and prices without a time lag. This base model of monetary policy is then extended to also include a measure of financial instability.[9] This allows us to study the interaction between financial instability, price stability and monetary policy.

Let Φ denote our index of financial instability. Our empirical model can then be written as the following four dimensional VAR model

$$A(L)\, z_t = \delta + \varepsilon_t \tag{1}$$

where $z_t = \begin{bmatrix} y_t & p_t & r_t & \Phi_t \end{bmatrix}'$, L is the lag operator, and the four dimensional vector of innovations ε_t is assumed to be a white noise sequence with $\mathrm{E}[\varepsilon_t] = 0$ and a nonsingular covariance matrix $\mathrm{E}[\varepsilon_t \varepsilon_t'] = \Sigma$. All variables are in logarithms.

To test empirically whether price stability and the goal of financial stability are mutually consistent goals of monetary policy, we rely on Granger causality tests within reduced form models and multiplier analysis within orthogonalized systems. If price shocks (or exogenous changes in the price level) affect financial instability whereas this effect cancels when also conditioning on the endogenous response of the interest rate, then the two goals of monetary policy are complementary. Similarly, we can investigate whether monetary policy also affects financial instability. Theoretical reasoning suggest that higher interest rates trigger financial instability. This direct effect may, however, be both stronger or weaker when we take endogenous price and output effects into account.

Within a VAR framework there are several ways of formulating noncausality hypotheses in equation (1).[10] Specifically, we can distinguish between two noncausality hypotheses.

[8] See Christiano, Eichenbaum and Evans (1999) for a comprehensive survey of the literature.

[9] In our empirical analysis, we estimate both 4 dimensional VAR models comprised of output, prices, the interest rate and a measure of financial instability, and a 5 dimensional VAR model where we also include the amount of lending in the economy.

[10] It would be more appropriate to change the term *causality* to *predictability*. But as the term causality is widely used we will follow the same tradition.

In relation to our model, the standard Granger test consists in examining, for example, whether the coefficients associated with the price level in the equation for financial instability are equal to zero. Second, it is also possible that effects from the price level to financial instability are transmitted through the other variables (output and the interest rate) in the system, see Lütkepohl (1989) or Bergman and Warne (1993).

In order to understand the relationship between these two sets of hypotheses we rewrite the reduced form VAR model in (1) as the following VMA model

$$z_t = A\,(1)^{-1}\,\delta + C\,(L)\,\varepsilon_t \tag{2}$$

Testing the hypothesis that the price level does not Granger cause financial instability can then be formulated as:

$$a_{42}(z) = 0 \quad \forall\ |z| \leq 1, \tag{3}$$

and

$$c_{42}(z) = 0 \quad \forall\ |z| \leq 1, \tag{4}$$

Letting $A(z)_{24}$ denote the 3×3 matrix polynomial obtained by eliminating the second row and the fourth column of $A(z)$, the scalar polynomial $c_{42}(z)$ is then given by

$$c_{42}(z) = -\det[A(z)]^{-1}\det[A(z)_{24}]. \tag{5}$$

Since the scalar polynomial $\det[A(z)_{24}]$ is of order $3p$ we find that $c_{42}(z) = 0$ if and only if $c_{42j} = 0$ for all $j \in \{1, \ldots, 3p\}$. Evaluating the determinant of $A(z)_{24}$ we obtain

$$\begin{aligned}\det[A(z)_{24}] \;=\;& a_{41}(z)[a_{22}(z)a_{33}(z) - a_{13}(z)a_{32}(z)] + a_{43}(z)[a_{11}(z)a_{32}(z) - a_{22}(z)a_{31}(z)] \\ &+ a_{42}(z)[a_{13}(z)a_{31}(z) - a_{11}(z)a_{33}(z)].\end{aligned}$$

The first term mainly contains the influence of the price level on financial instability which is transmitted via output while the second may be labeled the interest rate effect. Sufficient conditions for these effects to be zero are that $a_{41}(z)$ and $a_{43}(z)$ are both zero or that $a_{32}(z) = a_{22}(z) = 0$.

An interesting observation that can be made immediately from this discussion is that neither does the first hypothesis in (3) imply (4) nor does the opposite hold true. Note that the hypothesis in (4) is the hypothesis which conforms best with Granger's concept of noncausality (see, e.g., Granger (1969) and Lütkepohl (1989)). If the (3) is true while (4) is not, then clearly the price level only influences financial instability via other variables. Similarly, if (3) is not true while the (4) is, it follows that direct and indirect effects are both present but cancel out. This latter case implies, in our setting, that the price level affects financial instability directly, but that the interest rate and output also respond to price equation innovations such that the direct effect is cancelled.

According to the theoretical literature (Allen and Gale (2000)), a credit expansion could trigger a financial crisis in the economy by leading to excessive risk taking. To examine this channel, we extend the four variable VAR model above by including lending to the non–bank sector in the Swedish economy. Augmenting the VAR model with lending to the non–bank sector, we redefine the time series vector $x_t = \left[\begin{array}{ccccc} y_t & p_t & r_t & \Phi_{it} & B_{it} \end{array}\right]'$. The Granger noncausality tests of interest can now be formulated along the lines described above. For example, if we wish to test the hypothesis that lending (B) does not Granger cause financial instability, we have the following restrictions

$$a_{54}(z) = 0 \quad \forall \; |z| \leq 1, \tag{6}$$

and

$$c_{54}(z) = 0 \quad \forall \; |z| \leq 1, \tag{7}$$

The latter null hypothesis is satisfied if and only if $c_{54j} = 0$ for all $j \in \{1, \ldots, 4p\}$.

The relationship between exogenous shocks to the variables can be examined using orthogonalized or structural VAR models. A structural form of our model in (1) can be written as the following structural four dimensional vector moving average (VMA) system

$$\Delta z_t = \delta + R\left(L\right) \upsilon_t \tag{8}$$

where the structural shocks $\upsilon_t = \left[\begin{array}{cccc} \psi_y & \psi_p & \psi_r & \psi_\Phi \end{array}\right]'$ satisfies $\mathrm{E}\left[\upsilon_t\right] = 0$, and $\mathrm{E}\left[\upsilon_t \upsilon_t'\right]$ is diagonal, where ψ_i is output, price, monetary policy, and financial instability shocks respectively. The parameters in the lag polynomial $R\left(L\right)$ can be computed from estimates of the reduced form VAR model in (1). The basic idea is to identify the structural innovations υ_t in (8) as linear combinations of the reduced form disturbances ε_t in (1), i.e., to find a matrix F such that $\upsilon_t = F^{-1}\varepsilon_t$.

There are several different ways to identify the model. We will, as is common in the literature, assume that the monetary authority use contemporaneous information on output and prices when choosing monetary policy. However, output and prices do not respond contemporaneously to monetary policy shocks. Similarly, output, prices and monetary policy do not respond contemporaneously to financial instability shocks. The financial condition index is assumed to respond contemporaneously to all shocks in the system. These assumptions imply that we can use a Cholesky decomposition to fully identify our system. Within the identified system, we can study the linkages between monetary policy and financial instability. As suggested by the theoretical literature, a positive price and/or a contractionary monetary policy shock will lead to increased financial instability. Similarly, increased financial instability should lead to falling prices. The effect on monetary policy is ambiguous, it depends on if and how the monetary authority has reacted to financial instability. These predictions are examined using impulse response and variance decomposition analyzes.

To identify the lending shock within the five variable VAR model, we assume that a shock to financial instability cannot affect lending in the first period. We also assume that there is no contemporaneous effect from lending shocks on GDP, the price level and the interest rate. All other identifying restrictions are unchanged.

3 Empirical work

3.1 Data

The basic data set is comprised of quarterly observations on GDP, the underlying price level constructed by Sveriges Riksbank and the central bank interest rate. The data sources are reported in Appendix A. The sample is 1982:1 to 2001:3.

This standard model of monetary policy is then extended to also include a measure financial stability. Given the theoretical literature discussed above, this latter variable should reflect the stability of the banking sector. The fragility of the banking sector is closely reflected by the financial soundness of its customers. Banking crises tend to manifest themselves by heavy credit losses. Hence, time series on loan losses can be considered as a suitable crises indicator. However, quarterly data on Swedish bank's credit losses are not available for the whole sample we examine. One variable that could serve as an approximation of credit losses is the number of business failures, which generally trigger credit losses for the banks that lent to these businesses. Business failure statistics have the advantage of being published regularly, without a major time lag and available on a higher frequency.

Over recent decades, movements in property prices, in particular those of commercial property, have been central to the most pronounced financial cycles and banking system problems in developed economies. In part, this reflects the important role that property plays as a source of collateral for bank loans. Credit cycles are usually also associated with cycles in equity prices, although the links tend to be looser than those between credit and property prices. Furthermore, purchases of property are often debt financed implying that changes in property prices directly are reflected in households balance sheets as changes in net worth.

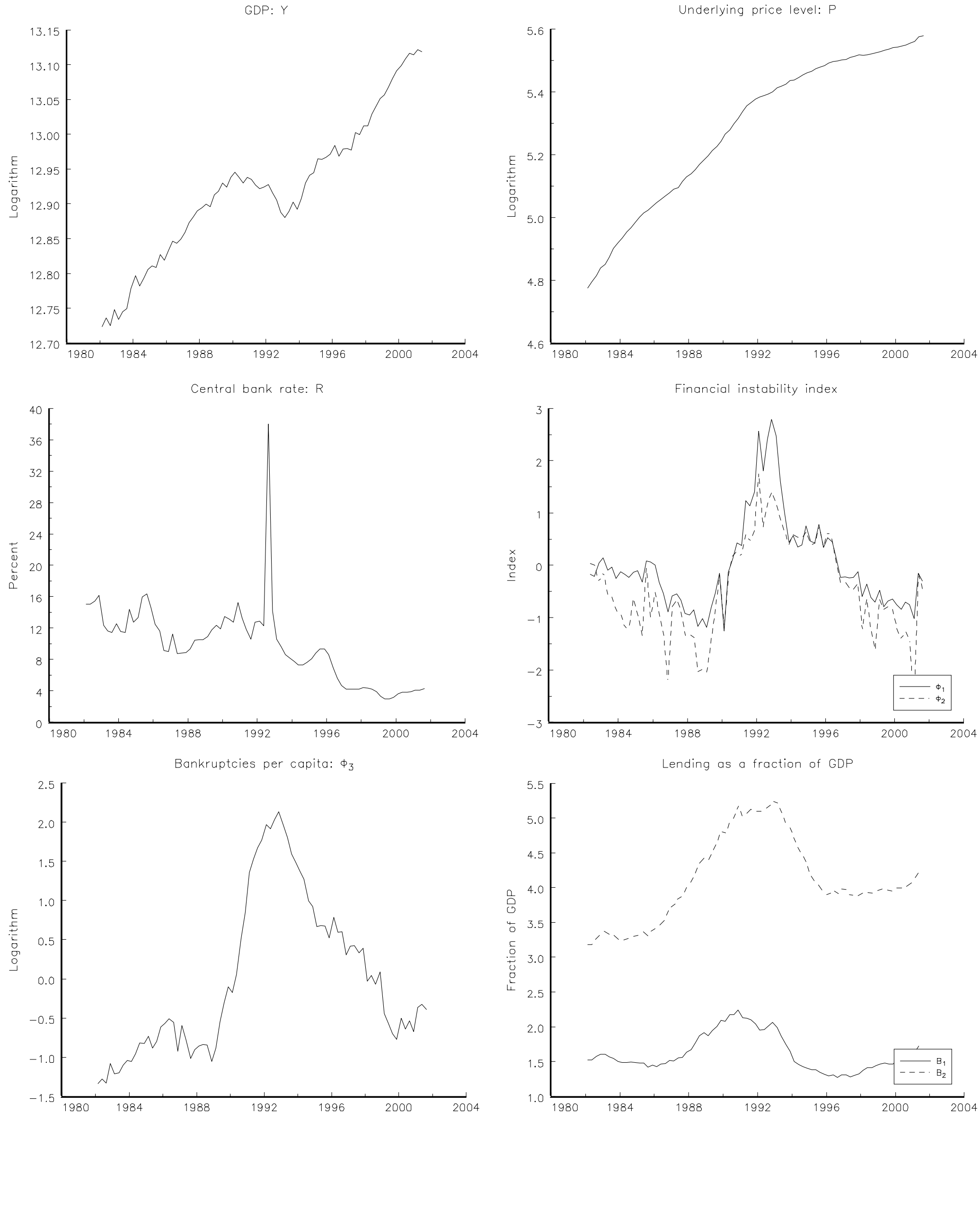
These considerations suggest that firm bankruptcies and excess return on housing can be used to construct an index of financial instability. Following Bordo, Deuker and Wheelock (2001), we construct two measures of financial instability using data on firm bankruptcies and excess returns on housing investments computed as the difference between the return of housing and the return from a long–term government bond. The first measure is defined as the standardized distance between these two series with equal weights, Φ_1, whereas the second measure also includes estimates of the conditional volatility of the underlying series, Φ_2. This latter index measures the standardized distance between the two series weighted by their relative conditional volatility. Appendix B explains in some detail how we construct these two indices. As a comparison, we also use the natural logarithm of firm bankruptcies in the Swedish economy per capita, Φ_3, as an index of financial instability.

Figure 1 shows plots of the data series we use in our empirical analysis. Looking first at the (log level) GDP, we observe the sharp downturn during the first part of the 1990's. The rapid upturn in real GDP following the abandonment of the fixed exchange rate policy in November of 1993, is clearly evident in the figure and GDP returned to the pre–1990 growth path in the beginning of 2001. This downturn in GDP coincides with the Swedish banking crisis where, for example, bankruptcies increased sharply from 1989 to its peak in 1994, see the graph plotting Φ_3. This same pattern is also noted, of course, for our other two measures of financial instability (Φ_1 and Φ_2) where we also have included the excess return from housing investments. The first half of the 1990's can be characterized as a period with a considerable degree of financial instability. The positive developments during the latter half of the 1990's also show up in the central bank rate which has decreased from about 15% in 1983 to 4% in 2001 while inflation fell to a lower level.

In the 5 dimensional VAR models, we also include lending by banks and all credit institutions to the private non–bank sector. The last graph in Figure 1 plots lending to the Swedish non–bank sector as a ratio of nominal GDP. The solid line is lending by banks to the private non–bank sector (B_1) whereas the dashed line is lending by all credit institutions to the private non–bank sector (B_2). The Swedish credit expansion following the deregulation of the credit markets 1983–85 is clearly evident in these graphs.[11] Lending by banks increased sharply during the latter part of the 1980's, from about 100% of GDP in 1987 to almost 200% of GDP in 1992. The rate of change in bank lending was almost 8% per year on average during the period 1983–87 and over 16% per year on average from 1987 to 1990. From 1992 to 1995, lending fell by on average 5% per year. Lending from all credit institutions shows a similar development during these years with a peak in 1992 where total lending to the non–bank sector was 5 times GDP on an annual basis. The average rate of growth was very similar to that of banking lending. The household sector reacted almost immediately to the deregulation by increasing its borrowing while corporations responded with a time lag of 2 to 3 years, see Englund (1999) who reports that lending to corporations increased by 129% while lending to households increased by 86% during the 1986–90 period.

[11]The deregulation involved abolition of liquidity ratios for banks in 1983, removal of interest ceilings for banks and placement requirements for insurance companies in 1985, and abolition of currency regulations in 1989. See, e.g., Englund (1990) for a thorough discussion about the Swedish deregulation.

Figure 1: Data series 1982:1–2001:3.



3.2 Model specification

Prior to our analysis of the linkages between financial instability, price stability and monetary policy, we have to decide, amongst other things, the lag order and the degree of integration in the data. Setting up three 4 dimensional models (one model for each of our measures of financial instability) comprised of the natural logarithm of GDP and the price level, the central bank rate in percent and financial instability, with a constant, a linear trend and a dummy variable to capture the 1992:3 episode, we find that the Schwarz information criterion suggest 2 lags for all four dimensional models. Schwarz information criterion suggest 1 lag in all five dimensional systems.

In Table 1 we report multivariate tests of the null hypothesis that the cointegration rank is less than or equal to the dimension of the system, and autocorrelation and normality of the residuals.[12] The LM test statistic and the Jarque–Behra test are both asymptotically χ^2 distributed.

From the reported p–values in Table 1, we find that the models pass the diagnostic tests, except for the normality test for the model where we use Φ_2 as our measure of financial instability in the 4 dimensional model and when using Φ_1 in the 5 dimensional models. We have also computed the roots of the characteristic polynomial and find that all roots have modulus less than one indicating that the estimated VAR models are stable. Indeed, formal tests for cointegration, using Johansen's trace test, show that we can reject the null hypothesis that $r \leq 3$ in our 4 dimensional models and that $r \leq 4$ in the 5 dimensional models, see Table 1. Note, however, that we rely on critical values for a model with linear trends in the data even if we have included the dummy variable. Keeping this in mind, we nevertheless interpret our evidence as suggesting that the models may be stationary.[13]

3.3 Analysis of the reduced form VAR model

Next, we turn to the relationship between the price level, the interest rate and financial instability within the reduced form VAR model. In Table 2, we report the results from testing the various Granger noncausality hypotheses discussed above in section 2. In the upper panel of the table we analyze the four dimensional VAR systems and in the lower two panels the five dimensional systems. Each panel consists of two or three rows with results

[12] We have also computed Engle's (1982) LM test for autoregressive conditional heteroskedasticity (ARCH) in the individual residual series. We find no indication of ARCH in the output, price and financial instability, and lending equations. For the interest rate equation we find, for some lag lengths, that we can reject the null hypothesis of no ARCH at the 5 percent level. These results are not shown here, but are available upon request from the authors.

[13] We have experimented with alternative model specifications allowing for non–stationarity and cointegration. Our results below are qualitatively unchanged when using these alternative model specifications.

Table 1: Multivariate tests for cointegration, autocorrelation and normality in reduced form VAR models.

4 dimensional VAR's; $z_t = \begin{bmatrix} y & p & r & \Phi_i \end{bmatrix}'$			
	Φ_1	Φ_2	Φ_3
LR–trace ($r \leq 3$)	4.08*	8.03*	6.57*
LM(6)	0.949	0.842	0.714
Jarque–Bera	0.000	0.358	0.162

5 dimensional VAR's; $z_t = \begin{bmatrix} y & p & r & B_1 & \Phi_i \end{bmatrix}'$			
	Φ_1	Φ_2	Φ_3
LR–trace ($r \leq 4$)	6.52*	6.60*	10.97*
LM(6)	0.990	0.989	0.762
Jarque–Bera	0.000	0.800	0.418

5 dimensional VAR's; $z_t = \begin{bmatrix} y & p & r & B_2 & \Phi_i \end{bmatrix}'$			
	Φ_1	Φ_2	Φ_3
LR–trace ($r \leq 4$)	4.36*	5.21*	6.70*
LM(6)	0.989	0.993	0.763
Jarque–Bera	0.000	0.576	0.344

Note: LR–trace ($r \leq 5$) is the Johansen's trace test of the null hypothesis that the number of cointegration vectors is less than or equal the dimension of the VAR system. ($*$) denotes significant at the 5% level. The multivariate LM tests for no autocorrelation at lag length 6 is χ^2 distributed with 16 and 25 degrees of freedom, respectively. The Jarque–Bera test is χ^2 distributed with 8 and 10 degrees of freedom, respectively. Only p–values of these latter tests are reported in the table.

for direct Granger noncausality ($a_{ij}(z) = 0$) and total Granger noncausality ($c_{ij}(z) = 0$). We denote the tests by $\mathrm{H_{GC}}(\Phi_i, p)$ which refers to testing the null hypothesis that p does not Granger cause Φ_i. All hypotheses are tested with the Wald test statistic.

First, consider the results for the four dimensional VAR's shown in the upper panel of Table 2. The upper row of this panel reporting the results from testing whether the price level Granger causes financial instability shows that we can reject the null hypothesis that the parameters associated with the price level are equal to zero in the equation for financial instability at the 10 percent level for two of our definitions of financial instability (Φ_2 and Φ_3) and slightly above the 10 percent level for the remaining definition (Φ_1). These results suggest that increases in the price level will lead to a higher degree of financial instability, a result consistent with the theoretical predictions from most models of financial crisis.[14] Turning to the tests whether the parameters associated with price equation innovations in the financial instability equation are zero, we find that this hypothesis is rejected at conventional significance levels for models with Φ_2 and Φ_3.

The second row of the upper panel of Table 2 shows the results from testing the null hypotheses that the interest rate does not Granger cause financial instability. These results show that we can reject all hypotheses at the 10 percent level regardless of how we measure financial instability. This finding is also consistent with predictions from the theoretical literature that interest rate changes do affect financial instability. As our point estimates of the relevant parameters in the VAR and VMA representations of the four dimensional models are positive, we conclude that higher interest rates lead to a higher degree of financial instability.

The lower two panels of Table 2 report the results from testing Granger noncausality hypotheses within five dimensional VAR models where we have added a measure of lending to the non–bank sector. When we include bank lending to the non–bank sector as a fraction of GDP (B_1) as the fifth variable, we obtain similar results from the Granger noncausality tests as we obtained for the four dimensional models. Both null hypotheses are rejected for the models with bankruptcies per capita as in the four dimensional case and the null that $a_{42}(z) = 0$ when using Φ_2. These results change, however, when including lending from all credit institutions to the non–bank sector. For these model specifications. we cannot reject any null hypothesis.

The inclusion of lending does not change the results when testing the null hypotheses that the interest rate does not Granger cause financial instability. Interest rate changes still significantly affect financial instability regardless of model specification. Turning to the question whether lending, a proxy for the amount of credit in the economy, does not Granger cause financial instability we find evidence suggesting that lending affects financial

[14]The sum of the autoregressive parameters $a_{ij}(z)$ is positive for all three model specifications.

instability, see the third row in the two lower panels of Table 2. A credit expansion does lead to an increase in the degree of financial instability, except for the model with Φ_2.

The results reported in Table 2 are in general in accordance to most economic theories that suggest a central role for shocks to the price level, the interest rate and lending in affecting financial instability. However, our results do not clearly show whether price stability and financial stability are complementary goals for monetary policy. In both four and five variable systems, price shocks seem to have less significant influence on financial instability when conditioning on monetary policy. On the other hand, interest rate changes significantly affect financial instability such that higher interest rates lead to a higher degree of financial instability. This suggests that a more stable interest rate is preferable if monetary policy also should aim at financial stability. Similarly, credit expansions modeled as an increase in lending to the non–bank sector as a fraction of GDP also lead to higher degrees of financial instability. This suggests that it is paramount to prohibit excessive credit expansions to maintain financial stability.

It must be kept in mind that our analysis so far has been carried out within reduced form models. To be able to compare the effects and durations of shocks to the price level, the interest rate and lending, on financial instability we turn to structural VAR analysis where we examine impulse response functions and variance decompositions.

3.4 Structural VAR model

In this subsection, we first provide impulse response functions for our different model specifications above using the Cholesky identification discussed in section 2. Figure 2 shows impulse response functions of our three measures of financial instability to price and interest rate shocks whereas Figure 3 shows responses of the (log) price level and the interest rate to financial instability shocks. Note that all graphs show the impulse responses to a one standard deviation positive structural shock. We also include the 90% confidence intervals computed using bootstrap simulations with 500 trials.

Consider first Figure 2 showing the impulse responses of financial instability to a one standard deviation shock to the price level and the interest rate. In general, we find that the impulse response functions are quite similar regardless of how we measure financial instability. Both positive price and interest rate shocks significantly raise the degree of financial instability. One notable feature of these graphs is that the effects from price shocks are very persistent. A positive price level shock leads to a significantly higher degree of financial instability for at least 10 quarters (up to 24 quarters when using Φ_2). As expected, contractionary monetary policy shocks lead to a higher degree of financial instability in the short–run. Comparing the impulse response functions, we also note that the effects from price shocks are very long–lived compared to the effects from monetary

Table 2: Granger noncausality tests in reduced form VAR models.

4 dimensional VAR's; $z_t = \begin{bmatrix} y & p & r & \Phi_i \end{bmatrix}'$

	Φ_1		Φ_2		Φ_3	
	$a_{ij}(z) = 0$	$c_{ij}(z) = 0$	$a_{ij}(z) = 0$	$c_{ij}(z) = 0$	$a_{ij}(z) = 0$	$c_{ij}(z) = 0$
$\mathrm{H_{GC}}(\Phi_i, p)$	4.548	9.625	8.792	12.014	5.049	11.178
	(0.103)	(0.141)	(0.012)	(0.062)	(0.080)	(0.083)
$\mathrm{H_{GC}}(\Phi_i, r)$	14.821	18.966	8.382	11.680	5.072	12.018
	(0.001)	(0.004)	(0.015)	(0.069)	(0.079)	(0.062)

5 dimensional VAR's; $z_t = \begin{bmatrix} y & p & r & B_1 & \Phi_i \end{bmatrix}'$

	Φ_1		Φ_2		Φ_3	
	$a_{ij}(z) = 0$	$c_{ij}(z) = 0$	$a_{ij}(z) = 0$	$c_{ij}(z) = 0$	$a_{ij}(z) = 0$	$c_{ij}(z) = 0$
$\mathrm{H_{GC}}(\Phi_i, p)$	1.554	2.755	4.631	5.975	4.584	13.280
	(0.212)	(0.600)	(0.031)	(0.201)	(0.032)	(0.010)
$\mathrm{H_{GC}}(\Phi_i, r)$	13.491	19.374	5.385	10.539	4.412	9.786
	(0.000)	(0.000)	(0.020)	(0.032)	(0.036)	(0.044)
$\mathrm{H_{GC}}(\Phi_i, B_1)$	2.445	10.016	2.696	10.024	10.053	30.985
	(0.117)	(0.040)	(0.101)	(0.040)	(0.001)	(0.000)

5 dimensional VAR's; $z_t = \begin{bmatrix} y & p & r & B_2 & \Phi_i \end{bmatrix}'$

	Φ_1		Φ_2		Φ_3	
	$a_{ij}(z) = 0$	$c_{ij}(z) = 0$	$a_{ij}(z) = 0$	$c_{ij}(z) = 0$	$a_{ij}(z) = 0$	$c_{ij}(z) = 0$
$\mathrm{H_{GC}}(\Phi_i, p)$	0.498	1.169	1.427	1.614	1.136	4.228
	(0.480)	(0.883)	(0.232)	(0.806)	(0.286)	(0.376)
$\mathrm{H_{GC}}(\Phi_i, r)$	14.461	17.421	6.581	10.798	5.474	7.127
	(0.000)	(0.002)	(0.010)	(0.029)	(0.019)	(0.129)
$\mathrm{H_{GC}}(\Phi_i, B_2)$	0.826	8.043	1.904	7.285	4.702	20.182
	(0.363)	(0.090)	(0.168)	(0.122)	(0.030)	(0.000)

Note: P–values are shown in parenthesis below each test statistic. Tests of the null hypothesis that $a_{ij}(z) = 0$ are χ^2 distributed with 2 degrees of freedom for 4 dimensional VAR's and 1 degrees of freedom for 5 dimensional VAR's whereas tests of the null that $c_{ij}(z) = 0$ are χ^2 distributed with 6 and 4 degrees of freedom, respectively.

policy shocks.

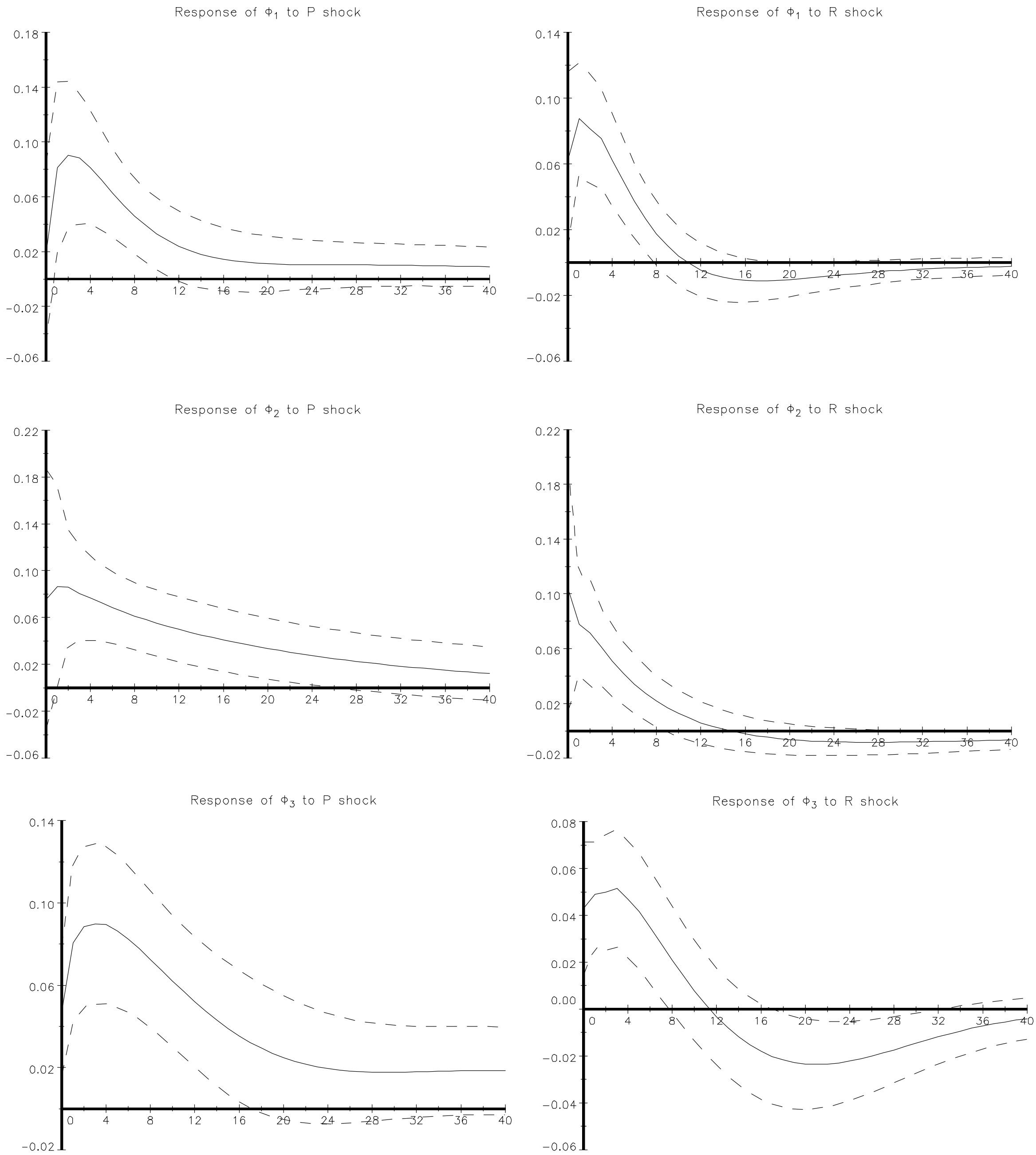
From Figure 2, we also note that a one standard deviation shock to the price level and to the interest shock give approximately the same size of the effects on financial instability. In the third model where financial instability only is measured by the number of bankruptcies per capita, the impulse responses are somewhat larger for the price level shocks. The estimated standard deviations of the structural shocks reveal, however, that the variance of the monetary policy shock is greater than the variance of the price level shock. The standard deviations of the structural price level shocks are of the order 8/100 whereas it is above 1 for the monetary policy shocks. This implies that a small shock to the price level yields approximately the same impulse response function of financial instability as a large shock to monetary policy. In other words, a one percentage points shock to the price level leads to a larger effect on financial instability than a one percentage points shock to the interest rate. This implies that more stable prices leads to a higher degree of financial stability compared to a more stable interest rate. This piece of evidence together with the more long–lived effects of price shocks lend support for the view that price stability, compared to interest rate stability, promotes financial stability.

Shocks to financial stability, on the other hand, tend to lower prices, at least in the medium term according to all three models, but the response is not significant at the 10 percent level, see the first column of Figure 3. This may not be that surprising as falling inflation in the beginning of the 1990s most often has been explained by a shift of monetary policy towards inflation targeting and in general a negative output gap, rather than by a credit crunch due to the banking crises. Interestingly, a positive shock to financial stability initially leads to tighter monetary policy. This indicates that monetary policy has contributed to aggregate financial instability throughout our sample. The interest rate response is statistically significant at the 10 percent level in two of our models and marginally significant on one model.

The forecast error variance decomposition of financial instability is shown in Table 3. These tables show, for the number of quarters ahead indicated, the fraction of the forecast error of financial instability attributable to shocks to the price level, the interest rate and financial instability. Standard errors computed using Bootstrap simulations with 500 trials are given in parentheses below each estimate. In these tables we also include the forecast error variance of the price level and the interest rate attributable to shocks to financial instability.

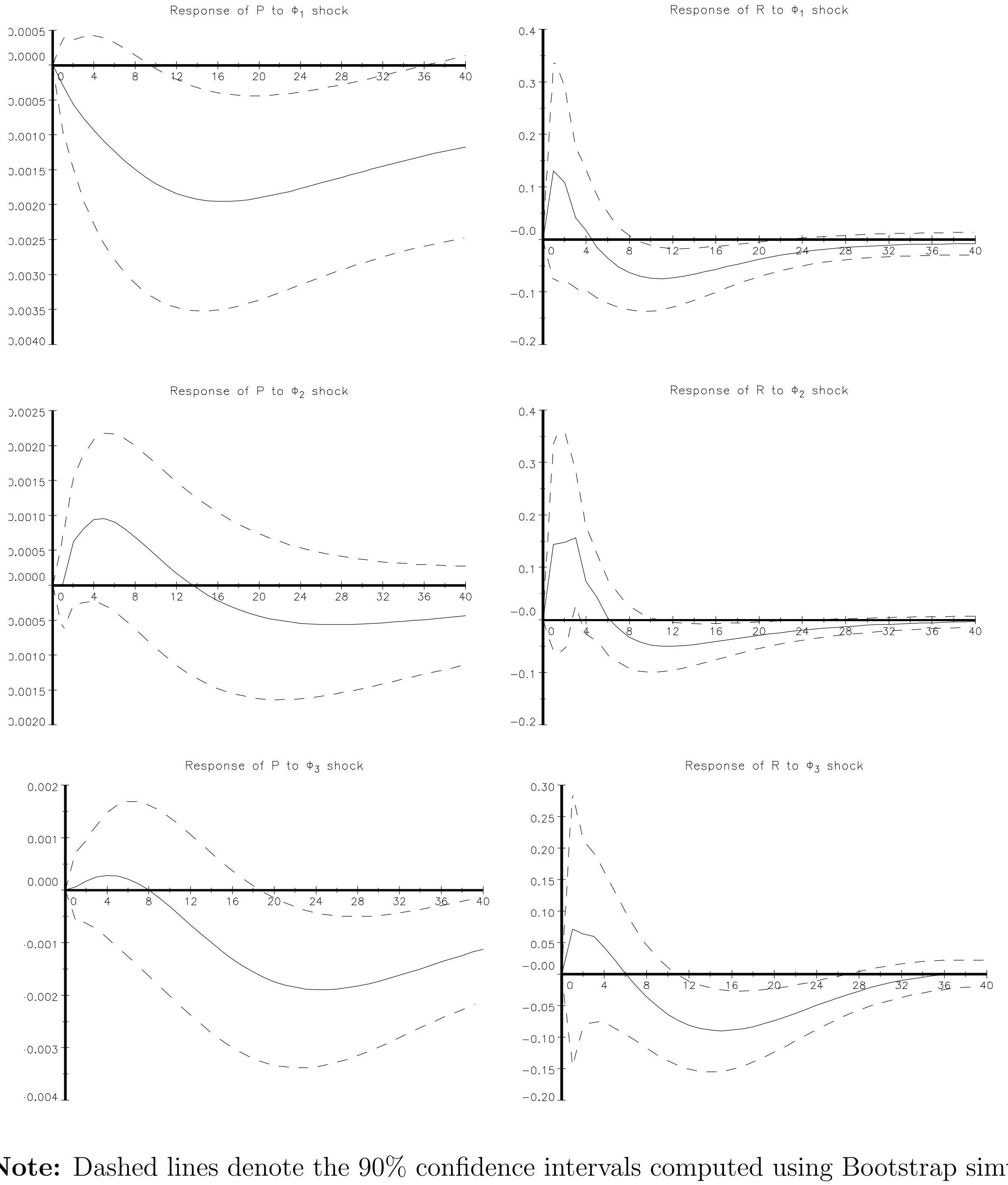
The forecast error variance decompositions, see Table 3, largely confirm the main results of the Granger noncausality tests and the impulse response analyzes. Shocks to financial instability explain the main part of financial instability at all time horizons, and in particular at short time horizons. This is not surprising, however, as a price level shock or a

Figure 2: Impulse responses of financial instability to a one standard deviation positive shock to the price level and the central bank rate.



Note: Dashed lines denote the 90% confidence intervals computed using Bootstrap simulations with 500 trials.

Figure 3: Impulse responses of the price level and the central bank rate to a one standard deviation positive shock to financial instability.



Note: Dashed lines denote the 90% confidence intervals computed using Bootstrap simulations with 500 trials.

monetary policy shock should not give an immediate and strong effect on financial instability. Shocks to output, the price level and the interest rate explain less than 40 percent of the forecast error of financial instability at the one year horizon. This fraction increase somewhat for all models when increasing the time horizon.

Price level and monetary policy shocks explain 18 to 37 percent of the forecast error variance of financial instability at the 1 year horizon. For longer time horizons, price shocks seem to explain a larger fraction of this forecast error, in particular for the model specification where we use bankruptcies per capita as our measure of financial instability. Price shocks explain 17 to 32 percent of the forecast error variance in financial instability at the 3 year horizon whereas monetary policy shocks only explain 7 to 13 percent.

Shocks to financial instability explain only small parts of the forecast error variance of prices and interest rates. Using the reported standard errors, we find that neither the price level nor the interest rate are significantly explained by shocks to financial instability. These results are consistent with the lack of significance of the impulse responses shown in Figure 3.

Next, we turn to the five dimensional VAR models where we also include the amount of lending to the non–bank sector as a fraction of GDP. Figure 4 shows the impulse responses of financial instability to a one standard deviation shock to lending and the 90% confidence intervals computed using Bootstrap simulations with 500 trials. The impulse response functions of financial instability to a lending shock are very similar for both measures of lending to the non–bank sector in all three models. As expected, a credit expansion in the short–run leads to a higher degree of measured financial stability as higher lending increases short–term aggregate demand and the level of economic activity. In the medium term, however, there is a statistically significant increase in financial instability. This result is also in line with the predictions from practically all theories on financial stability and the findings in earlier empirical studies that credit expansions in the medium term lead to financial stability problems. Comparing the sizes of the effects from lending, we find that the maximum impulse responses are very similar for our two measures. The duration of statistically significant effects differ however. In general, the effects are significant from 1 to 5 years. This evidence is consistent with earlier estimates suggesting that lending expansions lags banking crisis by 2 years.

Figures 5 and 6 show the impulse responses of financial instability to one standard deviation shocks to the price level and to the interest rate. Comparing the sizes and the durations of these impulse response functions the results for the four dimensional models in Figure 2, we still find that price shocks give more long–lived effects on financial instability than monetary policy shocks for the model specification where we use bankruptcies per capita. For the other two specifications, the impulse responses are either not statistically

Table 3: Forecast error variance decomposition. Fraction of forecast error variance in financial instability explained by price level (p), funds rate (r) and financial instability (Φ) shocks and the fraction of forecast error variance in the price level and the funds rate explained by financial instability shocks in percent.

		Φ_1		p	r		Φ_2		p	r		Φ_3		p	r
Horizon	p	r	Φ_1	Φ_1	Φ_1	p	r	Φ_2	Φ_2	Φ_2	p	r	Φ_3	Φ_3	Φ_3
1	0.3	4.0	95.1	0.0	0.0	2.6	5.0	92.2	0.0	0.0	9.0	7.4	83.6	0.0	0.0
	(4.6)	(4.4)	(6.3)	(0.0)	(0.0)	(5.5)	(5.8)	(8.0)	(0.0)	(0.0)	(7.1)	(5.7)	(8.8)	(0.0)	(0.0)
2	5.0	8.4	85.4	0.2	1.0	5.5	7.0	87.2	0.0	1.2	18.9	9.2	71.6	0.0	0.3
	(7.7)	(5.3)	(9.1)	(1.0)	(2.4)	(6.9)	(5.8)	(8.7)	(0.7)	(2.2)	(9.8)	(5.7)	(10.2)	(0.7)	(1.7)
3	8.7	10.4	79.9	0.6	1.5	7.5	8.1	84.1	0.7	2.2	23.8	9.7	65.6	0.1	0.5
	(9.4)	(5.8)	(10.4)	(1.7)	(2.8)	(7.5)	(6.0)	(8.9)	(1.5)	(2.8)	(11.1)	(5.8)	(11.1)	(1.1)	(1.7)
4	11.5	12.0	75.6	1.1	1.5	9.3	8.9	81.5	1.2	3.3	26.7	10.2	61.6	0.1	0.6
	(10.3)	(6.1)	(11.2)	(2.6)	(3.0)	(8.0)	(6.1)	(9.3)	(2.2)	(3.3)	(12.0)	(5.9)	(11.8)	(1.7)	(1.9)
8	17.3	13.4	67.8	3.3	1.7	14.3	9.7	75.6	2.2	3.4	31.3	9.1	51.6	0.2	0.7
	(11.6)	(6.2)	(11.9)	(5.9)	(3.2)	(8.9)	(6.1)	(9.9)	(3.5)	(3.3)	(13.4)	(5.7)	(12.2)	(4.4)	(2.4)
12	18.8	13.0	65.2	6.0	2.5	17.2	9.5	72.2	1.8	3.7	32.2	7.4	44.4	0.2	1.3
	(11.6)	(6.1)	(11.7)	(8.2)	(3.5)	(9.4)	(6.0)	(10.1)	(3.7)	(3.4)	(13.7)	(5.2)	(11.5)	(6.6)	(2.9)
16	19.0	12.8	64.0	8.6	3.3	19.0	9.1	69.7	1.4	4.0	32.0	6.8	39.7	1.1	2.6
	(11.6)	(6.1)	(11.7)	(9.6)	(3.7)	(9.6)	(5.8)	(10.2)	(3.9)	(3.5)	(13.8)	(5.0)	(10.8)	(8.5)	(3.4)
20	18.9	12.8	63.5	10.8	3.7	20.0	8.9	67.8	1.3	4.2	31.3	6.9	37.7	3.0	3.8
	(11.6)	(6.1)	(11.6)	(10.5)	(3.9)	(9.7)	(5.8)	(10.4)	(4.2)	(3.6)	(14.0)	(5.0)	(10.5)	(9.9)	(3.7)
40	19.2	12.8	62.8	15.4	4.1	21.3	8.6	63.7	1.8	4.4	29.7	7.8	39.4	11.1	4.8
	(11.7)	(6.0)	(11.7)	(11.9)	(4.0)	(10.2)	(5.6)	(11.3)	(5.1)	(3.6)	(14.5)	(5.1)	(10.9)	(12.2)	(4.0)

Note: Standard errors computed using Bootstrap simulations with 500 trials are shown in parenthesis below each statistic.

significant or have approximately the same degree of persistence. Furthermore, comparing the estimated standard deviations of the structural shocks, we still find large differences. The estimated standard deviation of monetary policy shocks in our five variable system are considerably larger than both lending and price shocks. As the maximum response of the three shocks are of about the same magnitude, we again find evidence supporting the view that it is more important to bring inflation under control and prohibit excessive lending expansions than to maintain a stable interest rate. Our results from these models are therefore mixed. Price shocks have significant effects only for models with bankruptcies per capita as our measure of financial distress. However, point estimates suggest stronger effects on financial distress from price shocks than from monetary policy shocks.

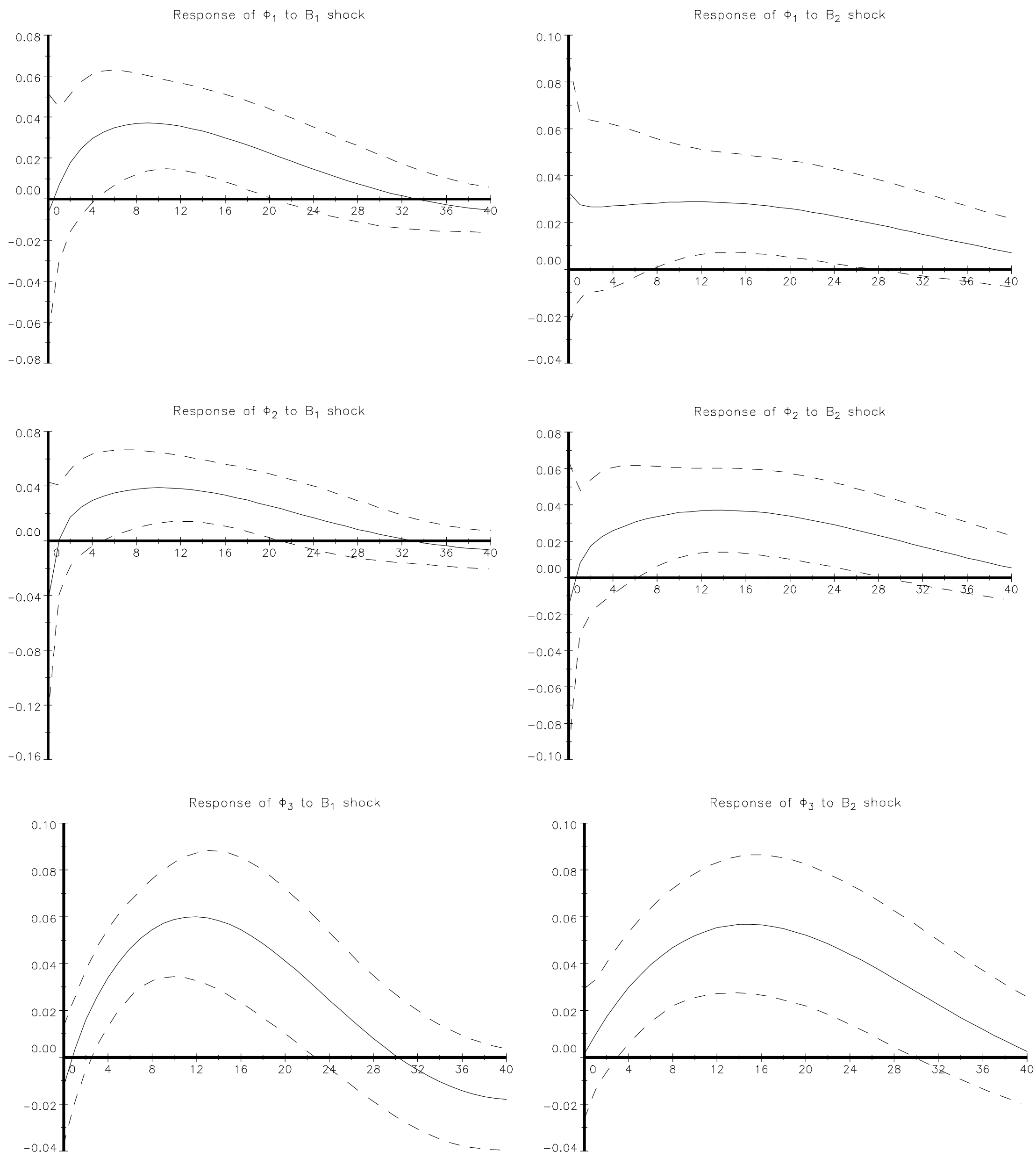
Finally, we turn to variance decompositions analysis to examine how important shocks to lending are in explaining financial instability. Table 4 reports the fraction of the forecast error of financial instability explained by shocks to lending for our three measures of financial instability and the two measures of lending.[15] For comparison we also report the fractions of the forecast error of financial instability explained by the sum of price and interest rate shocks and own shocks to financial instability. The evidence in this table suggests that credit expansions only explain small portions (not statistically significant at conventional levels for short–term horizons) of financial instability. The only exception is for the model with bankruptcies per capita where lending shocks explain 21 and 27 percent of the forecast error at the 4 year horizon.

These results are in large consistent with earlier findings in the literature. It has often been argued that the deregulation of the credit market contributed to the rapid credit expansion during the end of the 1980's which ultimately led to a banking crisis. Englund (1999), however, points at other explanations that also contributed to the Swedish banking crisis. In particular, Englund suggests that the interaction between an expansionary fiscal policy, a monetary policy aimed at maintaining a fixed exchange rate, and the Swedish tax system explain the boom in the Swedish economy. The credit expansion following the deregulations also contributed to the boom but played, according to Englund, a less important role.

Comparing the variance decompositions of the five dimensional models with that of the four dimensional models we note that the fraction explained by own shocks increases somewhat when including lending in the models. Also interesting is that the fraction explained by price shocks only, sharply decrease. In the five dimensional models, price shocks explain only small parts of the forecast error variance of financial instability. Moreover,

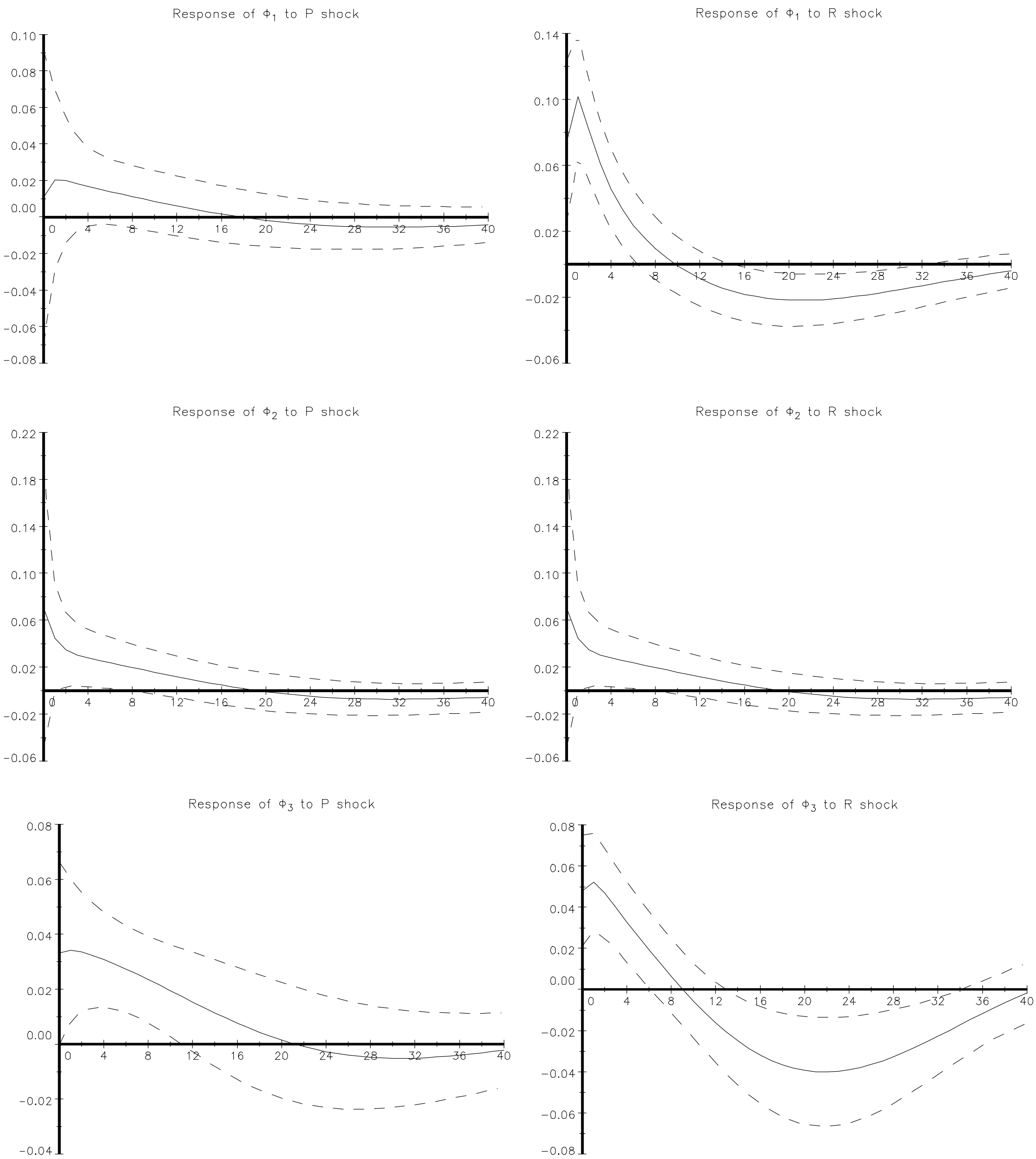
[15]The forecast error attributable to other shocks in the system are in large unaffected by the inclusion of lending. Therefore, we only report the fractions explained by lending shocks. All other results are available upon request from the authors.

Figure 4: Impulse responses of financial instability to a one standard deviation positive shock to lending as a fraction of GDP.



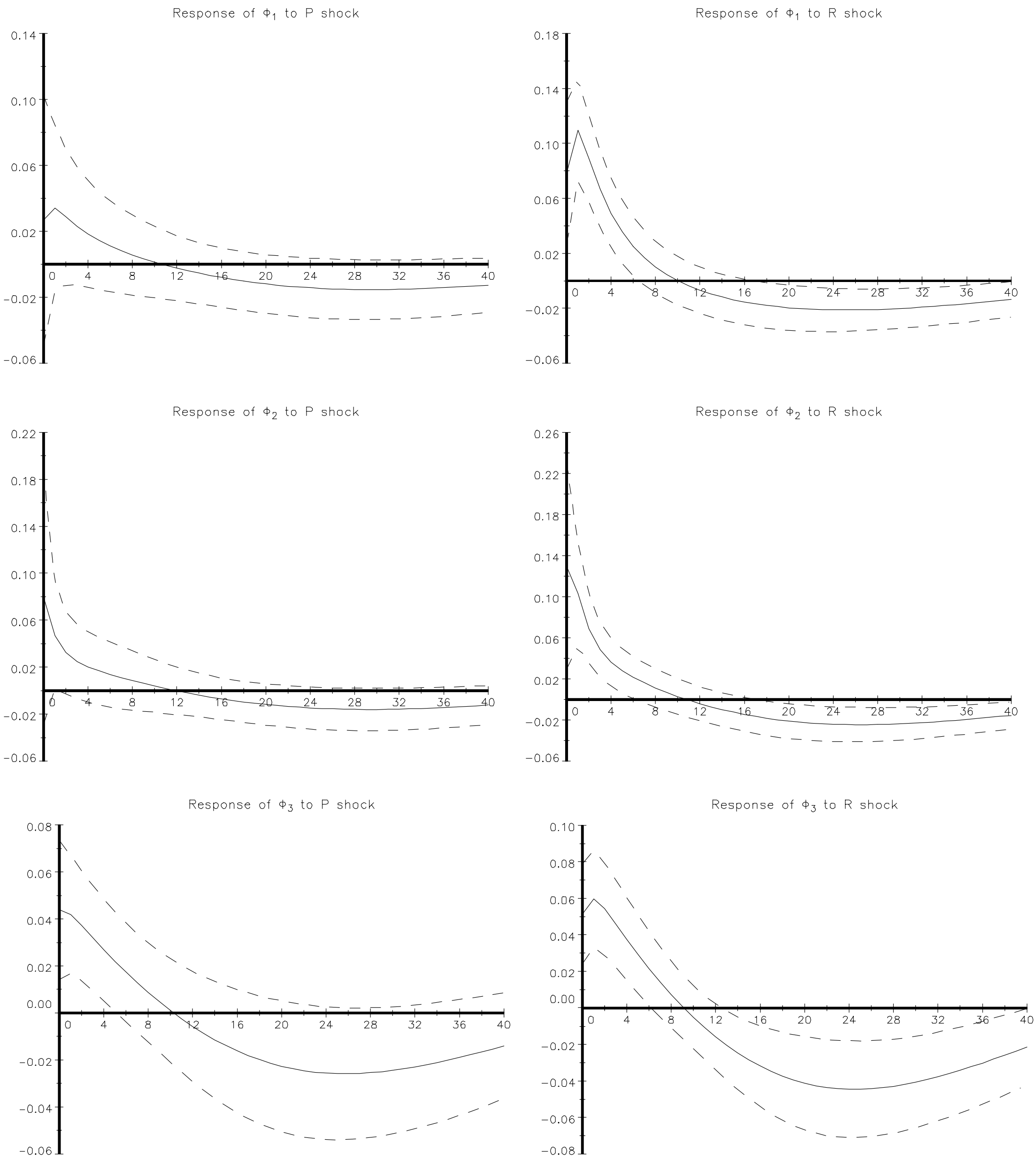
Note: Dashed lines denote the 90% confidence intervals computed using Bootstrap simulations with 500 trials.

Figure 5: Impulse responses of financial instability to a one standard deviation positive shock to the price level and the central bank rate within a five dimensional system with B_1.



Note: Dashed lines denote the 90% confidence intervals computed using Bootstrap simulations with 500 trials.

Figure 6: Impulse responses of financial instability to a one standard deviation positive shock to the price level and the central bank rate within a five dimensional system with B_2.



Note: Dashed lines denote the 90% confidence intervals computed using Bootstrap simulations with 500 trials.

the sum of the fractions explained by price and lending shocks is smaller than the fraction explained by interest rate shocks for all model specifications except for the model with Φ_3 and B_1. Still, the main part of financial instability is explained in our model specifications by own shocks. Given the much stronger negative effects on financial instability from both price shocks and lending shocks compared to shocks to monetary policy, we argue that our results can be interpreted as giving support to the view that monetary policy should aim at bringing inflation under control and prohibit credit expansions as this policy also promotes financial stability. A potential problem, however, is that lending booms usually coincides with low inflation levels. If monetary policy also is aimed at preventing credit expansions, there may be a conflict between the two goals of price and financial stability as a higher interest rate leads to increased financial fragility.

4 Historical decomposition

Our model can also be used to shed light over possible causes of the Swedish banking crisis during the early part of the 1990's. We decompose actual behavior of financial instability prior to and during the Swedish banking crisis into the parts attributable to the shocks we have estimated using the four and five dimensional VAR models. These historical decompositions are shown in Figures 7 and 8. In these graphs we plot the actual detrended behavior of financial instability for the period 1989:1 to 1994:4 and the implied movements in financial instability for price shocks and central bank rate shocks within the four variable models in Figure 7. In Figure 8 we show corresponding graphs four the five variable systems and the contribution of lending shocks in addition to the other two impulses.

Looking first at the historical decompositions of the four dimensional models in Figure 7. A general result is that price shocks explain more of the actual behavior in financial instability compared to central bank shocks regardless of how we measure financial instability. Monetary policy shocks do not contribute, according to these estimates, to the sharp increase in financial fragility during this period. It is also interesting to note that other shocks in the system, output shocks and own shocks to financial instability, explain large portions of financial fragility for two of our measures, Φ_1 and Φ_3. This implies that important factors explaining the Swedish banking crisis are not included in our model. Such factors could be financial liberalization, changes in the tax system for example that have been proposed as possible causes of the Swedish developments during the first part of the 1990's.

Turning next to Figure 8 where we show historical decompositions of financial instability in five variable VAR models. Adding lending to our systems affect our conclusions above

Table 4: Forecast error variance decomposition. Fraction of forecast error variance in financial instability (Φ) explained by price level (p), funds rate (r), financial instability (Φ) and lending (B) shocks in percent.

	B_1								
	Φ_1 explained by			Φ_2 explained by			Φ_3 explained by		
Horizon	$p+r$	B_1	Φ_1	$p+r$	B_1	Φ_2	$p+r$	B_1	Φ_3
1	5.6	0.0	93.8	9.1	0.8	89.8	13.6	0.6	85.8
	(6.3)	(2.3)	(7.1)	(7.4)	(2.8)	(8.5)	(8.0)	(1.8)	(8.6)
2	11.0	0.1	87.5	11.6	0.7	85.2	17.3	0.4	82.2
	(7.7)	(2.2)	(8.4)	(7.4)	(2.5)	(8.4)	(8.7)	(1.5)	(8.7)
3	13.4	0.2	84.1	12.6	0.7	81.9	19.4	0.8	79.4
	(8.2)	(2.6)	(9.1)	(7.4)	(2.4)	(8.6)	(9.1)	(2.3)	(9.1)
4	14.6	0.5	82.0	13.1	0.9	79.6	20.8	1.7	76.9
	(8.4)	(3.3)	(9.6)	(7.3)	(2.5)	(8.8)	(9.2)	(3.6)	(9.4)
8	15.7	2.7	78.1	13.8	2.2	75.6	22.4	10.4	66.6
	(8.3)	(5.5)	(10.3)	(7.1)	(3.7)	(9.2)	(9.0)	(8.2)	(10.3)
12	15.4	5.1	75.8	13.9	3.9	73.9	20.2	21.6	55.7
	(7.9)	(6.0)	(10.5)	(7.0)	(4.3)	(9.3)	(8.1)	(9.2)	(10.1)
16	14.8	6.8	73.2	13.6	5.3	71.4	17.6	27.0	49.6
	(7.6)	(5.6)	(10.9)	(6.8)	(4.3)	(9.7)	(7.6)	(8.9)	(10.0)
20	14.4	7.5	70.8	13.2	6.0	68.3	16.4	26.3	49.0
	(7.4)	(5.4)	(11.2)	(6.7)	(4.1)	(10.1)	(7.4)	(8.6)	(10.4)
40	14.3	7.3	66.8	12.8	5.8	61.1	17.1	20.0	53.5
	(7.3)	(5.3)	(11.8)	(6.5)	(4.1)	(11.1)	(7.6)	(8.5)	(11.1)

Note: Standard errors computed using Bootstrap simulations with 500 trials are shown in parenthesis below each statistic.

Table 4: Continued.

	B_2								
	Φ_1 explained by			Φ_2 explained by			Φ_3 explained by		
Horizon	$p+r$	B_2	Φ_1	$p+r$	B_2	Φ_2	$p+r$	B_2	Φ_3
1	6.7	1.1	91.8	10.1	0.1	89.5	17.1	0.0	82.6
	(7.3)	(3.1)	(7.4)	(7.5)	(2.0)	(8.0)	(8.9)	(2.2)	(8.8)
2	12.8	1.2	85.3	13.0	0.1	84.8	20.9	0.2	78.7
	(8.7)	(3.3)	(8.7)	(7.7)	(1.9)	(8.0)	(9.4)	(2.7)	(9.1)
3	15.5	1.4	82.3	14.0	0.2	81.9	22.6	0.6	76.5
	(9.2)	(3.8)	(9.3)	(7.7)	(2.0)	(8.2)	(9.8)	(3.7)	(9.4)
4	16.7	1.6	80.7	14.4	0.4	80.0	23.3	1.3	74.9
	(9.4)	(4.3)	(9.6)	(7.7)	(2.4)	(8.4)	(10.0)	(4.9)	(9.6)
8	17.7	2.9	78.4	14.7	1.4	76.8	22.6	6.7	68.8
	(9.3)	(6.1)	(10.2)	(7.6)	(3.9)	(8.9)	(10.0)	(8.8)	(10.2)
12	17.4	4.3	77.0	14.6	2.8	75.5	19.9	15.0	60.2
	(9.0)	(6.6)	(10.6)	(7.5)	(4.5)	(9.3)	(9.3)	(9.6)	(10.1)
16	17.1	5.5	75.1	14.3	4.4	73.6	18.0	21.5	52.7
	(8.8)	(6.5)	(11.0)	(7.3)	(4.6)	(9.8)	(8.5)	(9.2)	(10.2)
20	16.9	6.5	73.0	14.0	5.6	70.9	17.9	23.7	49.0
	(8.5)	(6.2)	(11.3)	(7.1)	(4.5)	(10.2)	(8.1)	(8.6)	(10.5)
40	17.4	7.4	66.1	14.2	6.6	60.4	21.3	18.7	51.4
	(8.2)	(5.8)	(12.2)	(6.9)	(4.6)	(12.1)	(7.9)	(8.4)	(11.5)

Note: Standard errors computed using Bootstrap simulations with 500 trials are shown in parenthesis below each statistic.

considerably. Price shocks are not that important any longer for explaining the increase in financial fragility. Lending shocks, on the other hand, tend to imply an increase in financial instability already in 1989. If no other shocks had affected the model during 1989, then financial instability would have increased. It may be the case that the effects from these shocks materialize after an impact lag as suggested in the literature searching for leading indicators of banking and currency crisis. Monetary policy shocks are also increasingly important compared to the the estimates from the four dimensional models. This result is consistent with the variance decomposition analysis above. One explanation for this is that interest rate shocks and shocks to lending interact to produce a higher degree of financial fragility and thereby reducing the role played by price shocks. Similarly to the results for the four dimensional models, we find that output shocks and own shocks to financial instability dominate. Comparing the contributions of these two shocks, our results suggest that own shocks are more important than output shocks. This also holds for the four dimensional models again suggesting that other factors not modelled in our VAR analysis explain the main part of the Swedish banking and currency crisis during the first part of the 1990's.

5 Summary

This paper examines whether price and financial stability are mutually consistent goals by setting up a standard quantitative model of monetary policy and extending this model to include measures of financial instability. We construct two measures of financial instability using data on bankruptcies and the excess return from housing investments following the method proposed by Bordo, Dueker and Wheelock (2000,2001). In addition, we also look at bankruptcies per capita as a measure of financial instability.

Within a four variable structural VAR model comprised of GDP, the price level, funds rate and financial instability, we find that positive price shocks exert a strong influence on financial instability in accordance to the asymmetric information theory and earlier findings in the empirical literature. Monetary policy shocks are also important but their influence is short–lived compared to the effects from price shocks. Comparing the relative size of the implied impulse responses, we find that a small shock to the price level leads to a larger effect on financial instability than a large monetary policy shock.

Extending the four variable model to also include measures of lending to the non–bank sector in the Swedish economy, we find that a credit expansion tends to increase financial instability in the medium term horizon, from 1 to 5 years ahead. This finding is consistent with earlier empirical results where credit growth leads to increased financial instability with a time lag of 2 years (Demirgüç–Kunt and Detragiache (1998,1999)) and the findings

Figure 7: The fraction of financial instability (Φ) explained by shocks to the price level (p) and the central bank rate (r) within four variable VAR models during the Swedish banking crisis 1989:1–1994:4.

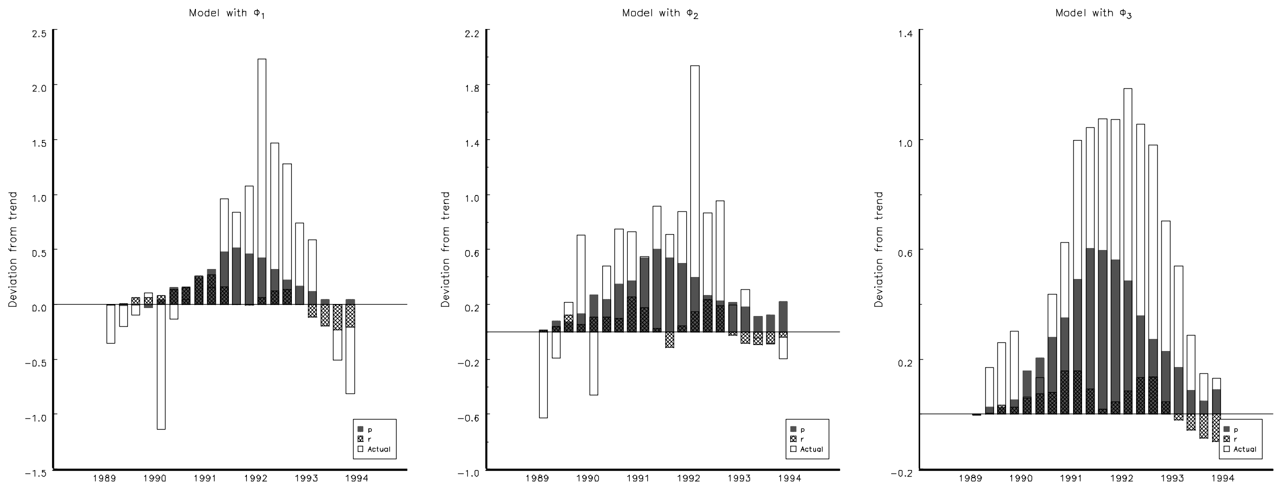
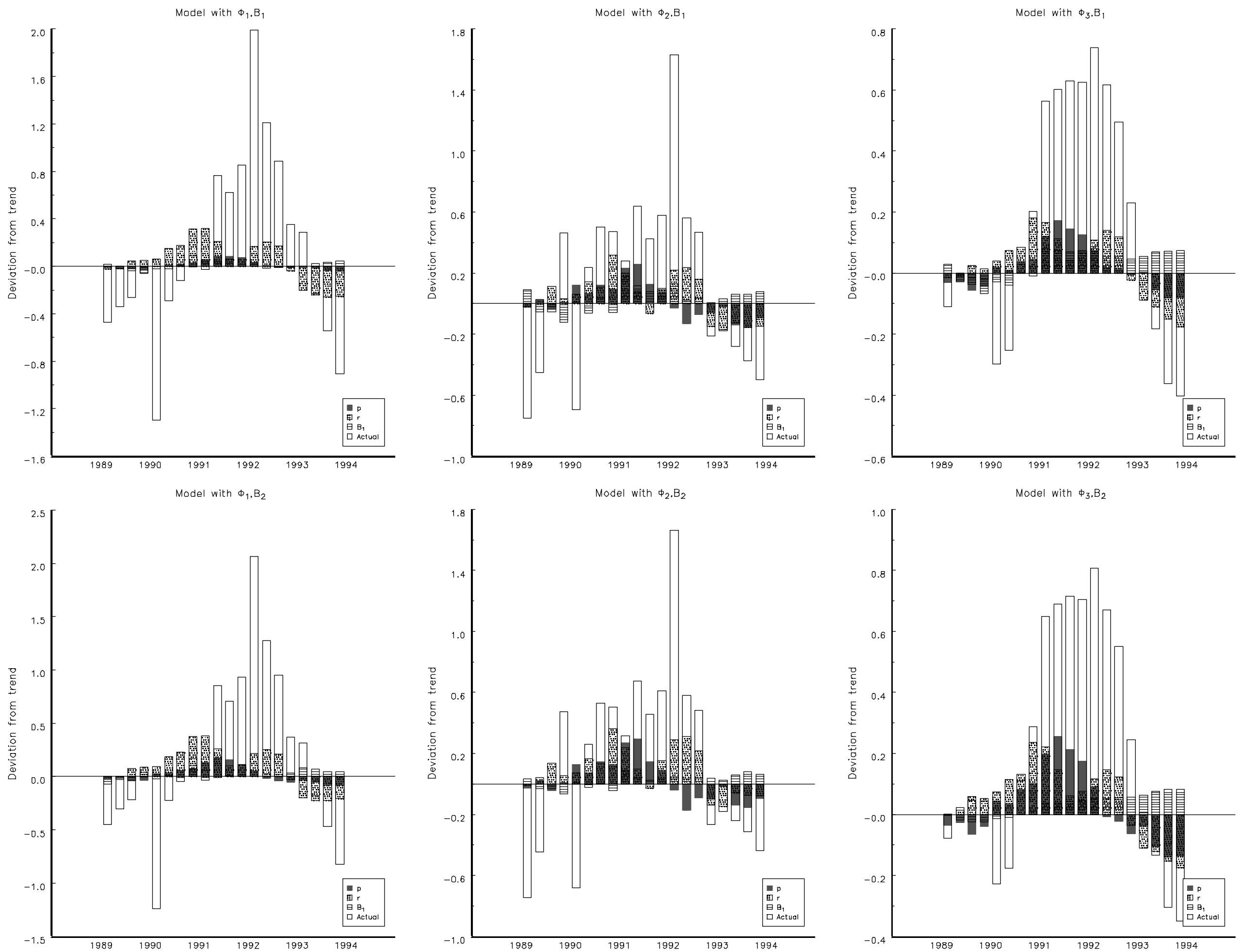


Figure 8: The fraction of financial instability (Φ) explained by shocks to the price level (p), the central bank rate (r) and lending (B) within five variable VAR models during the Swedish banking crisis 1989:1–1994:4.



that the credit/GDP ratio is a leading indicator of banking crisis (Kaminsky (1999)).

Dependent on how we measure lending, i.e., if we use lending by banks or by all credit institutions, we find that lending shocks can explain up to 15 percent of the forecast error variance of financial instability at the 3 year horizon. Nonetheless, price level and monetary policy shocks are, in general, more important for financial instability. In this respect, our results lend more support to the asymmetric information theory than to models suggesting that exogenous credit expansions are important factors explaining increases in financial instability.

Shocks to the price level are less important than monetary policy shocks within the five variable models compared to what we find in the four variable models. However, looking at the persistence of the responses of financial instability, comparing the size effects we still find that small price shocks can lead to large increases in financial instability and much larger effects than both monetary policy and lending shocks of the same size. Similarly, in a comparison of the estimated variance of the structural shocks, we find that small shocks to lending may lead to larger effects on financial instability compared to relatively large monetary policy shocks. These results do suggest that it is important that prices are stable and that excessive credit expansions are prohibited to maintain a stable financial system.

One should also keep in mind that our sample represent a worst case for the hypothesis that price stability and financial stability are mutually consistent goals for monetary policy as it is dominated by the banking and currency crisis during the 1990's and the shift from a fixed exchange rate regime to inflation targeting which was successful in bringing inflation under control. When this policy was initiated, the first signs of the emerging banking crisis was evident.

Looking more closely on the Swedish banking and currency crisis during the 1990's using historical decompositions we find that price shocks were more important than monetary policy shocks in explaining the increase in financial fragility during the first part of the 1990's within our four dimensional models. When we add lending to our models, monetary policy shocks became more important and price shocks less important. However, the main part of the sharp increase in financial fragility is explained by own shocks to financial fragility and output shocks. In this respect, our results suggest that other factors (other than price and monetary policy shocks) explain why the Swedish banking and currency crisis emerged in the early 1990's.

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Appendix A: Data sources

All series are (if necessary) seasonally adjusted. Most of the variables are logarithmically transformed. Unless otherwise stated, the variables are real.

Bankruptcies Bankruptcies of firms, share of the population. Seasonally adjusted. Sources: Statistics Sweden and Sveriges Riksbank.

GDP: y GDP in constant prices, seasonally adjusted. Sources: Statistics Sweden and Sveriges Riksbank.

Price level: p Consumer price index, underlying (UND1X). Seasonally adjusted. Sources: Statistics Sweden and Sveriges Riksbank.

Funds rate: r Interest rate, controlled by the Riksbank, nominal. Source: Sveriges Riksbank.

House prices House prices, real, deflated by consumer prices. Sources: Statistics Sweden and Sveriges Riksbank.

Lending by banks: B_1 Lending by banks to the Swedish private non-bank sector, ratio of nominal GDP. Source: Sveriges Riksbank.

Total lending: B_2 Lending by all credit institutions to the Swedish private non-bank sector, ratio of nominal GDP. Source: Sveriges Riksbank.

Appendix B: Construction of financial condition indices

This appendix describes the method used to construct two indices of financial instability. These indices were suggested recently by Bordo, Dueker and Wheelock (2001) in connection to a study of the effects of price shocks on financial instability. Using data on bankruptcies per capita, x_{1t}, and the excess return on housing computed as the difference between the return on housing and the yield on long–term government bonds, x_{2t}, we compute the standardized distance between these two series according to

$$\Phi_1 = \frac{1}{2}\left[\frac{x_{1t} - \overline{x}_1}{\sigma_{x_1}} + \frac{x_{2t} - \overline{x}_2}{\sigma_{x_2}}\right]$$

where $\overline{x}_1$ and $\overline{x}_2$ are the averages while σ_{x_1} and σ_{x_2} are the standard deviations.

The alternative measure suggested by Bordo, Dueker and Wheelock is to also condition on changes in the volatility in each series. Using estimates of an AR(2) model with GARCH(1,1) errors, we obtain an estimate of the conditional volatility.[16] The estimated conditional variance (σ_{x1t} and σ_{x2t}) and their averages can then be used to compute the following financial condition index

$$\Phi_2 = \lambda_t \left[\frac{(x_{1t} - \overline{x}_1)\overline{\sigma}_{x1t}}{\sigma_{x_1}\sigma_{x1t}}\right] + (1 - \lambda_t)\left[\frac{(x_{2t} - \overline{x}_2)\overline{\sigma}_{x2t}}{\sigma_{x_2}\sigma_{x2t}}\right]$$

where

$$\lambda_t = \left(1 + \frac{\sigma_{x1t}\overline{\sigma}_{x2t}}{\sigma_{x2t}\overline{\sigma}_{x1t}}\right)^{-1}.$$

[16] We have experimented with different specifications for the conditional variance model and found that a GARCH(1,1) model gives a good description of the data. Bordo, Dueker and Wheelock use an exponential GARCH(1,1) model. The asymmetry term was not significant for our data.

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