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How Resilient is the German Banking System to Macroeconomic Shocks?

by Jonas Dovern, Carsten-Patrick Meier, and Johannes Vilsmeier

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Kiel Institute for the World Economy, Düsternbrooker Weg 120, 24105 Kiel, Germany

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Abstract: Macro-stress testing studies often rely on rather short sample periods due to the limited availability of banking data. They may fail to appropriately account for the cyclicality in the interaction between the banking system and macroeconomic developments. In this paper we use a newly constructed data set on German banks' income and loss statements over the past 36 years to model the interaction between the banking sector and the macroeconomy. Our identified-VAR analysis indicates that the level of stress in the banking sector is strongly affected by monetary policy shocks. The results rationalize the active behavior of central banks observed during periods of financial market crises.

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JEL classification: C32, E44

Jonas Dovern
Kiel Institute for the World Economy
24100 Kiel, Germany
Telephone: +49-(0)431-8814-266
E-mail: Jonas.Dovern@ifw-kiel.de

Carsten Patrick Meier
Kiel Institute for the World Economy
24100 Kiel, Germany
Telephone: +49-(0)431-8814-267
E-mail: Carsten-Patrick.Meier@ifw-kiel.de

Johannes Vilsmeier
University of Regensburg
93040 Regensburg, Germany

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Jonas Dovern[Σ] Carsten-Patrick Meier[*] Johannes Vilsmeier[**]

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Macro-stress testing studies often rely on rather short sample periods due to the limited availability of banking data. They may fail to appropriately account for the cyclicality in the interaction between the banking system and macroeconomic developments. In this paper we use a newly constructed data set on German banks' income and loss statements over the past 36 years to model the interaction between the banking sector and the macroeconomy. Our VAR analysis indicates that the level of stress in the banking sector is strongly affected by monetary policy shocks. The results rationalize the active behaviour of central banks observed during periods of financial market crises.

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1 Introduction

Macroeconomic stress testing of the banking system has become an important tool for financial stability analysis (Sorge 2004). While stress testing at the level of individual banks has been widely applied by banks since the early 1990s, macroeconomic stress testing as a means to assessing entire financial systems is more recent. Motivated by the financial crises in emerging markets and the increasing world wide integration of financial markets, central banks and international institutions in the late 1990's took lead in augmenting the micro

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[Σ] Corresponding author. Kiel Institute for the World Economy (IfW). jonas.dovern@ifw-kiel.de.
[*] Kiel Institute for the World Economy (IfW).
[**] University of Regensburg. The author worked on the paper during a research visit to the Kiel Institute for the World Economy.

perspective at the individual bank by a macro perspective that addresses overall financial stability. Even though the weakness of individual banks possibly will be the trigger to larger crises, it is mostly the deterioration of macroeconomic environment that makes the single bank fail and may cause chain reactions in a tightened surrounding (Gavin et al. 1996). Major crises in the financial system, therefore, cannot simply be dispatched as a result of failures in single institutions; it is the interaction between the financial system and macro-economy that drives the dynamics. Increasingly central banks study this interaction to assess the resilience of the financial system, especially the banking system, to extreme but plausible shocks to its operational environment (ECB 2006, 147-153). The most extensive appliance of macroeconomic stress testing so far has been accomplished by the IMF as part of its Financial System Assessment Programs (FSAPs).

As a field of academic research, macroeconomic stress testing is rather new. First publications mainly evaluated the basic analytical tools and approaches used within the FSAP launched by the IMF and the World Bank (e.g. Blaschke et al. 2001). In more recent years, several contributions have attempted to measure and analyse the influence of macroeconomic shocks on the stability of financial systems. They offer different approaches to carry out macroeconomic stress testing. Initial approaches, used e.g. by Kalirai and Scheicher (2002) and the IMF in its country FSAPs, rely on single factor sensitivity tests. They look at the impact of a marked change in one variable, say e.g. the policy interest rate, on banks' balance sheets (Hoggarth et al. 2005). Kalirai and Schleicher (2002) use the aggregated loan loss provision as an indicator for the soundness of the Austrian banking sector. Using single equations and a large array of macroeconomic variables, they find that e.g. an increase in short-term interest rates or a cutback in industrial production have remarkable impacts on loan loss provisions. The drawback of this approach is that it does not allow for interaction between macroeconomic variables. And obviously no "shock-scenarios" involving shocks to more than one macroeconomic indicator can be implemented.

Consequently, later studies have been based on either larger scale structural macroeconomic models or on VAR approaches. Hoggarth et al. (2005) apply a "pure macroeconomic approach" using a VAR model in their stress test for UK banks. They include write-offs as financial stress indicator and (among other variables) the output gap, the short-term interest rate, and the exchange rates. Their results suggest that following unexpected increases in the output gap the ratio of write-offs to the volume of loans decreases. Recent studies which adopt the same methodology as Hoggarth et al. (2005) are for instance Marcucci and Quagliariello (2005), who analyze the cyclical behaviour of default rates of Italian bank borrowers, or Filosa (2007), who explores how adverse macroeconomic shocks may impair Italian banks' soundness. Both studies show that there are significant interactions between the health of the banking sector and macroeconomic conditions. Pesaran et al. (2003) use VAR models to assess the impact of macroeconomic variables on firms' probabilities of default in a so called micro-macro approaches, in which they use firm specific as well as macroeconomic data.

To orthogonalize the variance-covariance matrix, all of the above mentioned papers that use VAR models apply a Cholesky decomposition of the residual covariance matrix. Doing so, they have the drawback that a particular ordering of the variables must be adopted. Other identification procedures were suggested by Blanchard and Quah (1989) or recently by Uhlig (2005), whose approach has been adopted by Worms et al. (2006) in the framework of modelling financial markets. Worms et al. analyze how bank lending to the private non-banking sector responds dynamically to aggregate supply and demand shocks as well as monetary policy shocks in Germany and the Euro area. They find that the volume of loans increase in response to all three shocks, though more persistently in Germany than in the Euro area.

While the latter study is not primarily concerned with stress testing, another recent contribution, which deals with the stability of the German banking sector and uses the sign-restriction method, is presented in De Graeve et al. (2008). In this paper the authors investigate how monetary policy shocks affect financial stability. Furthermore, they quantify the importance of feedback mechanisms between the real and financial sector using an integrated micro macroeconomic approach. Thereby they extend the work of Jacobsen et al. (2005) who analyze interactions between the Swedish macroeconomy and the corporate sector. The macroeconomic part of their model consists of a standard VAR. The banking sector is modelled at the micro level using bank specific data. Using a logit model, probabilities of bank distress are linked to bank specific variables and the macroeconomic environment. The two parts of the model are then combined to yield an integrated "micro-macro" model which takes into account bi-directional feedback effects.

A general problem, which all of the mentioned approaches face, is the availability of only a scarce amount of data on the banking system. Using quarterly data, aggregate balance sheet information usually is available for not more than 15 years (Hoggarth et al. 2005). In addition it is questionable if the allocation of balance sheet entries to specific quarters reflects the true occurrence of events along the time dimension. Specific information on data for individual banks is usually available even more sparsely. Consequently, much of the existing empirical literature is based on rather small samples which typically cover only a limited number of business cycles.

This is where the present paper adds to the literature. We present an assessment of how the German banking sector reacts to macroeconomic shocks based on a long history of macroeconomic and banking data. The newly constructed data set stretches over 36 years and includes four complete business cycles. As our main indicator for stress we use data from the banks' income statement, in particular the write-off ratio.

The empirical work is based on the Bayesian estimation of a structural VAR which requires imposing only a minimum of sign-restrictions to identify the structural shocks (Uhlig 2005). We identify a contractionary monetary policy shock, a negative demand shock, and a negative supply shock by imposing short-run sign-restrictions on the vector of the impulse responses. The advantage of using a VAR model is that we avoid modelling the exact structure of the economy, the banking sector and the transmission channels. In addition, the identification of structural shocks via the sign-restriction approach is very convenient because our results do not depend on e.g. the order of the variables or similar restrictive assumptions. In addition, the VAR approach allows for potential feedback effects from the financial sector onto the real economy. Following an adverse macroeconomic shock, banks could for instance restrain credit volumes due to asymmetric information problems which could – in an extreme case – lead to a credit crunch scenario (Yuan and Zimmermann 2004) that would amplify the initial negative shock on the real economy.[1]

Our results suggest that especially contractionary monetary policy shocks significantly worsen the soundness of the banking sector. This is reflected in a quite strong increase in write-offs and a considerable decrease in return on equity. In contrast, supply shocks as well as demand shocks cause less vehement declines in return on equity and do not provoke remarkable changes in the level of write-offs. The results indicate, hence, that the way how monetary policy is conducted is of utmost importance for the financial stability of the banking sector.

The remainder of the paper is organized as follows. Section 2 provides information on the new data set used. Section 3 briefly describes the applied

[1] See also Hubbard (1995) or Bernanke et al. (1999) among others for a discussion on how the banking sector might propagate business cycle shocks.

estimation technique, presents the empirical model, and discusses the identification assumptions. Section 4 presents the empirical results and their interpretation. Finally, section 6 concludes the paper.

2 The Empirical Model

The model we use to study the interaction between the banking sector and the macroeconomy is an augmented version of the standard monetary VAR. The standard monetary VAR comprises three variables, real GDP, consumer prices (CPI), and the 3-months interest rate. We augment this standard setup by including US GDP as an exogenous variable – to account for the fact that Germany is a rather open economy – and by a variable that represents the state of the aggregate banking sector. The latter variable is treated as an additional endogenous variable; it should be interpreted as a proxy for the soundness of the German banking system.

A deterioration of the macroeconomic environment which makes a single bank fail and may eventually trigger a larger crisis will likely be expressed in a general worsening of banks' balance sheets. Thus, it seems obvious to measure stress in the banking sector using balance sheet items of the aggregated banking sector – in particular those items that are hit most vehemently by adverse macroeconomic shocks. Different proposals are made in the literature regarding which items would indicate best the possible strengths or vulnerabilities of financial sectors. Popular measures are for instance based on the level of non-performing loans, interest margins for outstanding loans or various liquidity ratios. In this paper we use two measures to describe the soundness of the aggregated bank sector; on the one hand write-offs, and on the other hand return on equity. The first primarily provides a measure for credit risk; the second implies a more general approach which may display credit risk as well as market risk.

The banking data set is constructed mainly from the print issues of the monthly bulletin of *Deutsche Bundesbank*. Since 1976, the Bundesbank has been publishing detailed data on the aggregate income and loss statement of the German banking system once a year in their monthly bulletin. This data covers the period of 1969 to 2005. In addition, we use data on loans from the Bundesbank's *Bankenstatistik*. By construction, all banking variables used in the present paper refer to the banking sector as an aggregate. We calculate write-offs as the quotient of the sum of total write-offs and value-adjustments2 relative to the total amount of outstanding loans. Return on equity is defined as profits after tax divided by the amount of total equity.

The macro data for Germany[3] is taken as reported by the German statistical office (*Statistisches Bundesamt*), *Eurostat*, and the *Federal Reserve Bank of St. Louis*. Due to the creation of the European Monetary Union in the 1990s, the time series for the short-term interest rate refers to the 3-month Fibor before 1999 and to the 3-month Euribor afterwards. Note that, since the banking data from income and loss statements is available at an annual frequency only, the whole analysis is based on annual data. While this means that we have only a rather limited number of observations, the data set enables us to consider a long sample period which covers a larger number of complete business cycles than are usually included in stress testing studies.

The data series are shown in Figure 1. The upper left panel shows that our sample covers four recessions (1975, 1982, 1993, and 2002) and the corresponding full business cycles. A first visual inspection also reveals that aggregate write-offs behave clearly countercyclical to the business cycle with the tendency of lagging behind one or two years. The correlation between growth and return on equity is less clear-cut in the first place. It is noteworthy that the huge write-offs in the aftermath of the new economy boom led to unprecedented low levels of return on equity during the years 2002 to 2004.

[Insert Figure 1 about here.]

3 Identification Strategy and Assumptions

3.1 The Sign-Restriction Approach

Consider a VAR in reduced form (neglecting a possible intercept and/or time trend for notational simplicity)

$$Y_t = B(L)Y_{t-1} + u_t, \qquad (1)$$

[2] The official German term is "Abschreibungen und Wertberichtigungen auf Forderungen und bestimmte Wertpapiere sowie Zuführungen zu Rückstellungen im Kreditgeschäft".
[3] Data before 1991 refer to West Germany. To obtain long time series, German and West-German data have been chained in 1991.

where the vector Y_t includes the variables of interest, *B(L)* is a lag polynomial of order *p*, and u_t is the vector of error terms with variance-covariance matrix Σ. Having estimated the parameters of this reduced form model of the macroeconomy, we are interested in the responses of the variables in Y_t to various structural shocks. To this end, the vector of prediction errors, u_t, of the reduced-form VAR has to be translated into a vector of economically meaningful structural innovations. The essential assumption in this context is that these structural innovations are orthogonal to each other. Consequently, identification amounts to providing enough restrictions to uniquely solve (up to an orthonormal transformation) for the following decomposition of the $n \times n$ estimated covariance matrix of the VAR given in (1):

(2) $$\Sigma = A_0 A_0'$$

This defines a one to one mapping from the vector of orthogonal structural shocks v_t to the reduced-form residuals, $u_t = A_0 v_t$. Because of the orthogonality assumption, and the symmetry of Σ, $n(n-1)/2$ restrictions on A_0 need to be imposed.

Initially it has been proposed to obtain these restrictions by choosing A_0 to be a Cholesky factorization of Σ, implying a recursive ordering of the variables as in Sims (1986). This method has been questioned on various grounds (see e.g. Sims 1992, Grilli et al. 1996, or Christiano et al. 1999). Although, alternative identification schemes like for instance the Blanchard-Quah approach (Blanchard and Quah 1999) have been introduced in the past, none of them has remained without criticism (Fernald 2007).

We follow an approach recently proposed by Uhlig (2005), which achieves identification of the VAR by imposing sign-restrictions on the impulse responses of a set of variables. Uhlig (2005, Proposition A.1) shows that, given an arbitrary decomposition A_0 of the matrix Σ, a structural impulse vector a can be represented as $a = A_0 q$ for some *n*-dimensional vector q of unit length. Thereby the arbitrary decomposition A_0 represents a lower triangular Cholesky factor of $\sum$. To identify one structural shock, we first estimate the coefficients of the *B(L)* matrix using OLS. For a given structural impulse vector a, the impulse responses of n variables up to horizon S can be calculated as

(3) $$r_s = [I - B(L)]^{-1} a,$$

where r_s denotes the vector of impulse response functions (IRF) at horizon *s*. Sign-restrictions can be imposed on $m \leq n$ variables over the horizon $0,\ldots,S$. Identification of the model is then achieved by simulation. The general idea of the simulation algrorithm can be briefly summarized as follows.

First, an estimate of $B(L)$ is obtained via OLS-estimation of the VAR. Second, we repeatedly draw possible vectors q and compute the corresponding IRFs up to horizon *S*. Third, for each draw we check whether the sign-restrictions imposed for the identification of a particular shock are satisfied. If the restrictions on all variables are satisfied, we see this draw as successful and keep it. Finally, after completion of the simulation the set of successful draws can be used to compute the median IRFs and corresponding confidence bands. For the specifics of this Bayesian estimation strategy we refer to Appendix B in Uhlig (2005). In our case, we abort the simulation after having accepted a total of 10,000 draws.

This so called pure sign-restriction approach has several advantages. First, compared to conventional approaches like identification through recursive ordering of the variables or long-run zero restrictions, sign-restrictions are relative mild identifying assumptions. The obtained results are for instance insensitive to the chosen decomposition of Σ or the ordering of the variables in the VAR. Second, this method involves simultaneous estimation of the reduced-form VAR and the impulse vector. This implies that the draws of the VAR parameters from the unrestricted posterior that do not fulfil the sign-restrictions receive a zero prior weight (Sarno et al. 2007). Finally and most important in our setup, we do not have to take any stance on how the banking sector should respond (contemporaneously and with lags) to a particular shock. Instead, we are free to let the data speak about the effects of the shocks on the banking sector.

3.2. Identifying Assumptions

As noted before, we use a VAR with annual frequency to investigate the relationship of the macroeconomic sector and the stance of the banking sector. In this model the macroeconomy is represented by GDP, the CPI and the 3-months interest rate plus US GDP and the banking sector is either modelled by its write-off ratio or by its return on equity. The VAR is used to investigate the impact of structural shocks onto the real economy and the banking system. By using an unrestricted VAR, interaction between the macroeconomic variables and most importantly also feedback effects from the financial sector back onto the real economy are possible. To identify the three structural shocks we impose sign-restrictions on the impulse responses as described in the following section. We identify a contractionary monetary policy shock, a negative demand shock and a negative supply shock. To this end, we impose the following restrictions.

After a contractionary monetary shock we require the short-term interest rate to increase, GDP is supposed to decrease, and prices should fall. In response to a negative demand shock GDP is assumed to decrease as well as prices and the interest rate. To identify a negative supply shock, we presume falling GDP and rising prices, while the interest rate is left unrestricted. These restrictions are imposed on the contemporaneous and one-year-ahead reactions of the variables. The same identification schemes have previously received substantial support in other empirical work (e.g. Worms et al. 2006, Peersman et al. 2006) and are summarized in Table 1. Note that the response of the interest rate to a supply shock is left unrestricted. This is because a positive as well as a negative sign for the response can be derived from economic theory. A positive sign can be justified as the increasing price level due to the shock brings the central bank to raise the interest rates in order to meet a supposed target inflation rate. On the other hand Galí et al. (2003) show that the sign may as well be negative since in a forward looking model the optimal monetary policy response to a supply shock depends on the persistence of the shock. Is the shock highly persistent, the expected future income and thus aggregate demand may fall by more than current aggregate supply so that the optimal monetary policy response may be to decrease the nominal interest rate (Worms et al. 2006).

[Insert Table 1 about here.]

As has been pointed out before, we explicitly do not impose restrictions on the reaction of the bank variables, since we want to allow the data to have the complete say on the dynamic response of write-offs and return on equity. Given that we work with annual data, we choose $S=1$, i.e. we require that the particular response patterns apply to the contemporaneous reaction of a variable and to its behaviour during the first year after a shock has occurred.

5 Empirical Results

In what follows we present the results of the empirical analysis. Figure 2 shows the IRFs to a monetary policy shock for a horizon up to 20 years after the shock.

In each graph we plot the median of the impulse responses. Following Uhlig (2005), we report as well the 16 percent and 84 percent quantiles to be able to infer the significance of our results. All results are based on 10000 accepted draws during the estimation procedure discussed in section 3.

[Insert Figure 2 about here.]

Panel A shows that the response of the system to an adverse monetary shock exhibits the usual pattern for the general-economy-part of the model: The interest rate is increased by about 75 basis points, the inflation rate is dampened by about 25 basis points, and the response of GDP growth shows the well known hump-shaped profile with the maximum negative impact of about 0.3 percent being reached one year after the shock. It takes about five years until the effects of the shock one GDP growth have been decayed. The response of the inflation rate is somewhat more persistent and takes almost ten years to fade out. The lower right part of the figure indicates that the monetary policy shock significantly increases write-offs in the banking sector up to three years after the shock. The ratio of write-offs relative to the amount of outstanding loans increases on impact by five basis points and declines gradually over the following six years. The magnitude of the response might appear small. However, noting that the sample average ratio is 0.41 percent, it becomes clear that the effect is very significant also in economic terms. Turning to our second indicator for distress the results show that the same shock decreases return on equity about 0.7 percentage points (Panel B). Here, it takes about eight to nine years for the shock to entirely decline. The responses of both distress indicators are statistically significant over a couple of years.

An intuitive explanation for the results could be the following. The adverse monetary shock moves interest rates up. Due to the higher costs of refinancing for commercial banks, loans for both investment and consumption purposes will be priced higher which causes GDP growth to slow down and also a lower inflation rate. Through this credit-channel the response of output and prices are potentially stronger as induced by the monetary shock in the first place.

The results concerning the stress induced into the banking system by aggregate demand shocks are not as clear-cut. While write-offs do not seem to significantly react to a demand shocks at all, we find a marginally significant decline of return on equity one to two years after the shock (Figure 3). Also here, however, the magnitude is smaller than for the monetary policy shock. This non-involvement of the banking sector in terms of distress following a demand shock can be explained by the expansionary monetary policy during the aftermath of the shock. The policy rate is cut immediately by three quarters of a percentage point. Apparently, this helps to stabilize the banking sector despite the fact that output declines much more initially than following the adverse monetary policy shock.

[Insert Figure 3 about here.]

The results with respect to an adverse supply shock show that the responses of return on equity as well as for write-offs are insignificant for all horizons (Figure 4). But not only are the IRFs not significantly different from zero; also the median responses are much smaller in size then for the two other types of shocks.

[Insert Figure 4 about here.]

To check the robustness of these results with respect to the identification approach we calculate IRFs based on the traditional Cholesky decomposition. Regarding the ordering of the variables we proceed as follows. First – contemporaneously affected by only one shock - we put GDP growth, followed by the inflation rate and the short-term interest rate. Write-offs or return on equity is the fourth variable in the VAR (which is affected instantaneously by all shocks) respectively. By this ordering we make the assumption that all macroeconomic variables can have contemporaneous influence on the banking sector while the feedback effects on the real economy occur delayed only.

Although the interpretation of the four structural shocks in this identification scheme is not directly comparable to the one in the sign-restriction approach, we can interpret the third shock (column 3) of the system as a monetary policy shock (affecting the interest rate and the banking sector contemporaneously while having no immediate impact on the inflation rate and GDP-growth) and compare the corresponding IRFs with those of Figure 2. The results confirm the signs for the responses of both bank variables after the monetary policy shock (Figure 5). We conclude that our results are fairly.

[Insert Figure 5 about here.]

Despite the fact that the results are consistent and seem to be robust, a number of potential caveats concerning the results and the applied approach should be addressed. First of all, it might be criticized that we restrict our analysis to a linear model. As shown for instance by Drehmann et al. (2006), non-linearities can matter significantly in macroeconomic stress testing if the true data generating process behind the model is not linear. They show that large shocks might have a more than proportional effect when compared to the effects of moderate shocks. Marcucci et al. (2006) point to another potentially important non-linearity. They employ a threshold model and show that the impact of business cycle shocks on the banking sector is more pronounced when the initial credit risk level is already high. We have, however, to deal with a very scarce data situation. It is simply not possible to estimate the required additional parameters in e.g. a regime-switching model that would serve to catch non-linearities.

Another potential drawback of our approach is that we do not explicitly model contagion effects among banks. We have to bear, hence, the risk that our results potentially underestimate the amplitude of the banking sector's response to macroeconomic shocks as we do not account for the internal dynamics in the sector. Implicitly, however, the historical data on the aggregate banking sector includes the effect of possible contagion so that we are little worried about this point.

Finally, one might argue that our distress measures are no perfect indicators for the soundness of the banking sector. On the one hand, write-offs might only be an imperfect proxy for the evolution of credit risk in the banking sector (Sorge 2004). On the other hand, also return on equity may not be a perfect measure. Prevailing accounting standards allow companies to some extend to shift entries in the earnings statement between quarters. This affects profits or losses as stated in the earnings statement and is known as so called "earnings smoothing" (Goel and Thakor 2003). The figures on return on equity might, hence, not reflect the 'fundamental' situation of a bank (e.g. in terms of cash flow/liquidity situation).

We leave the analysis on whether we could improve with respect to the choice of indicators for future research. In general, however, we think that given the data situation one should not lie to much emphasis on those caveats.

6 Conclusions

This paper analyzes the impact of macroeconomic shocks on the soundness of the German banking sector on basis of a VAR approach. It is complementary to existing literature on macroeconomic stress testing in that it is based on a substantially longer sampling period than existing studies and in that the idenfification via the sign-restriction approach (Uhlig 2005) relies only on a relatively weak set of assumptions.

We estimate two VAR models and identify various structural shocks. The models differ with respect to the included indicator of stress in the banking system. One model contains write-offs, the other one return on equity. We estimate the impulse response functions for a contractionary monetary policy shock as well as a negative demand shock and a negative supply shock. The monetary policy shock has the largest impact on the stress indicators. Both write-offs and return on equity respond statistically significant to the shock. The effects are also significant in economic terms. In contrast, the aggregate demand shock induces stress into the banking system to a much more limited extend. The results show only marginally significant responses which are also in magnitude smaller than following a monetary policy shock. We do not find any significant response of the distress indicators following an aggregate supply shock. In general, the results turn out to be robust with respect to the methodology used to identify the structural shocks.

During the recent crisis on the credit markets – triggered by the problems on the US mortgage market – the Fed, the ECB, and the Bank of England reacted very quickly to ensure the functioning of financial markets. The provision of additional liquidity and more expansionary policy in terms of the policy rates than had been expected before the crisis became urgent can be seen as an expansionary monetary policy shock. Our results rationalize this behaviour of the central banks to prevent banking crises. They suggest that monetary policy plays indeed a central role for the stability of the banking sector that is more important than demand or supply shocks.

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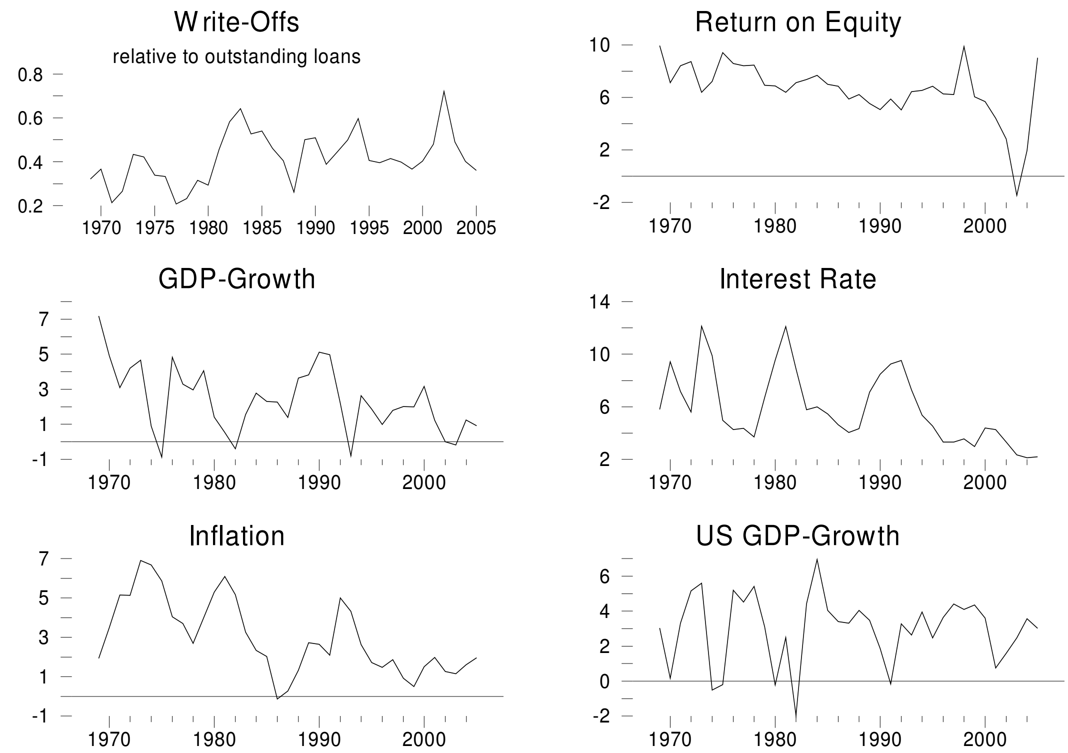
Appendix

Table 1: Pattern of sign-restrictions

	Adverse Monetary Policy Shock	Adverse Aggregate Demand Shock	Adverse Aggregate Supply Shock
GDP Growth	-	-	-
Inflation	-	-	+
Interest Rate	+	-	?
Stress Indicator	?	?	?

This table shows the identification schemes for different structural shocks in the sign-restriction approach. A "+" indicates that we require the corresponding variable to increase for a defined number of periods when the shock hits the economy. A " - " means that we require the corresponding variable to decrease for a defined number of periods when the shock hits the economy. We place a "?" in the table when we do not make any identifying restriction on the response of the corresponding variable.

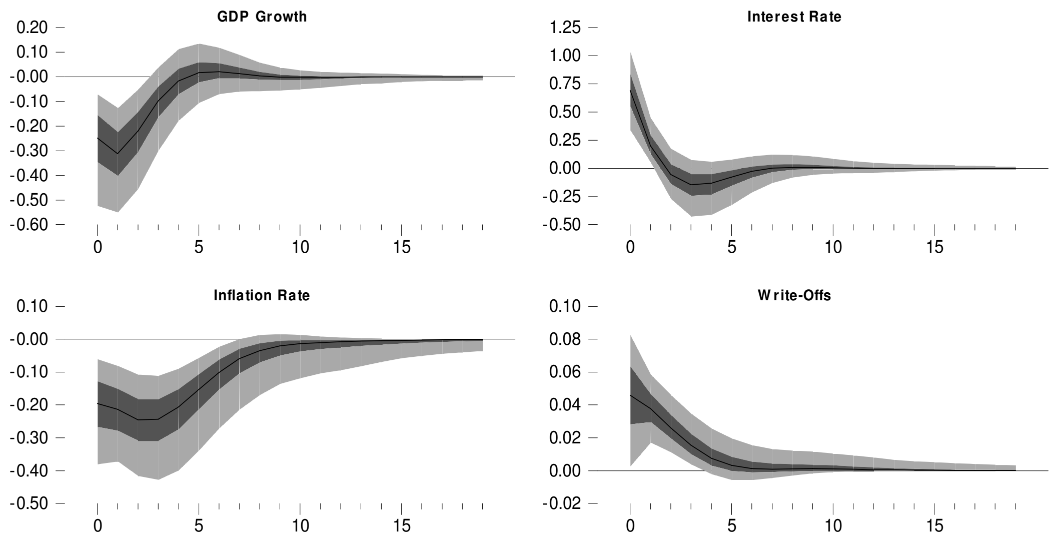
Figure 1: Banking sector stress and the macroeconomy – Germany 1969-2005



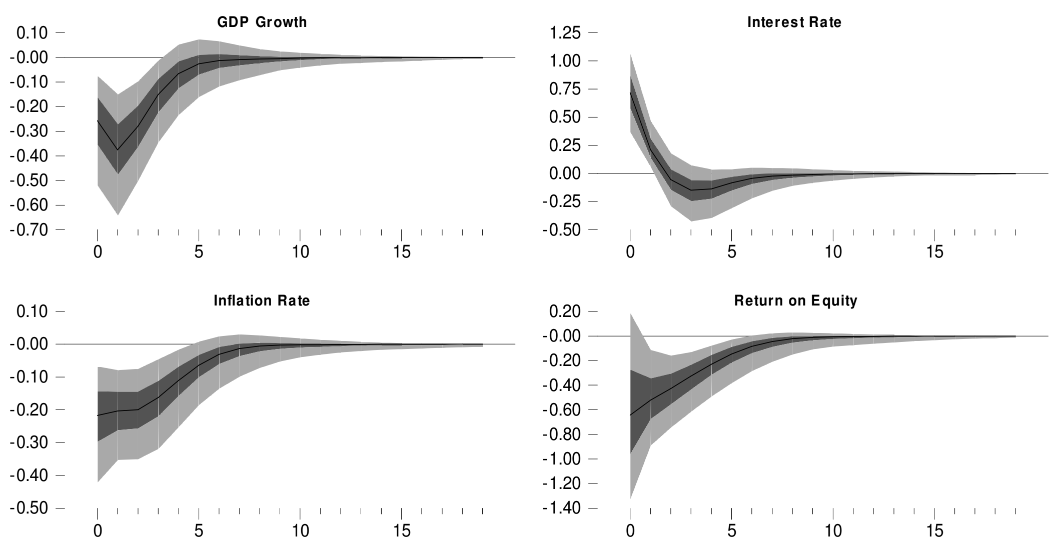
Notes: The figure presents the data that is used to estimate the VAR models. Write-Offs are defined as the ratio of the sum of total write-offs and value-adjustments to the total amount of outstanding loans. Return on equity is defined as the ratio of net income to equity. GDP-Growth and US GDP-Growth refer to the annual growth rate of real gross domestic product for Germany and the US respectively. Interest Rate is the 3-months money market rate (Euribor for the period starting in 1999 and Fibor until 1998). Inflation refers to the annual change of the consumer price index. All numbers are given in percent.

Figure 2: Impulse responses to a contractionary monetary policy shock

Panel A:



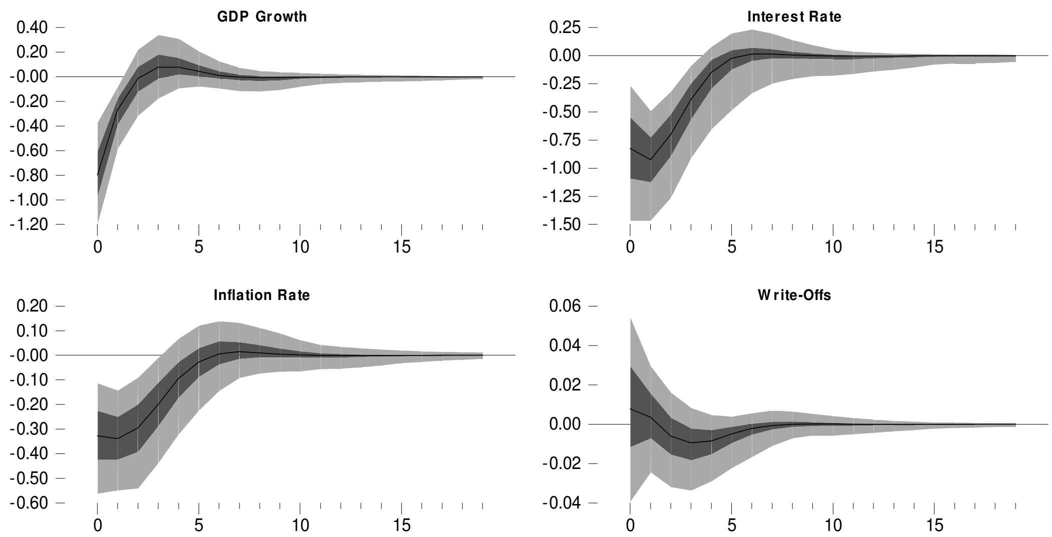
Panel B:



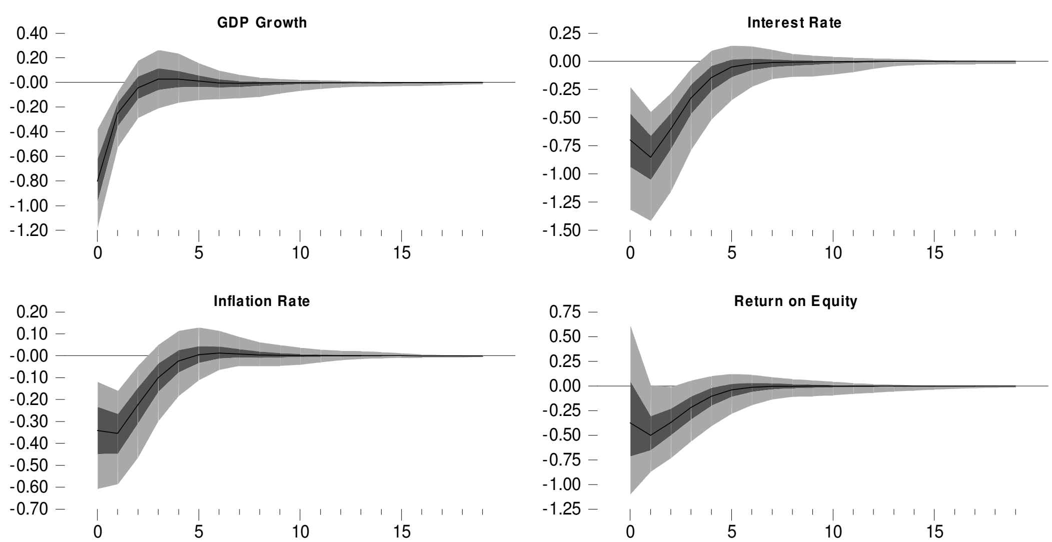
Notes: The figure shows the impulse responses to a contractionary monetary policy shock estimated from two VAR models with four endogenous variables (GDP-Growth, Interest Rate, Inflation, and Write-Offs or Return on Equity respectively) and one exogenous variable (US GDP-Growth). Identification of the structural model is achieved by the sign-restriction approach. The results are based on 10,000 draws in the identification procedure. The black lines indicate the median of the impulses. The two areas of the fan charts represent the 33 percent (dark grey) and 66 percent (light grey) confidence bands respectively. Panel A: Responses in the model with Write-Offs. Panel B: Responses in the model with Return on Equity.

Figure 3: Impulse responses to an adverse aggregate demand shock

Panel A:



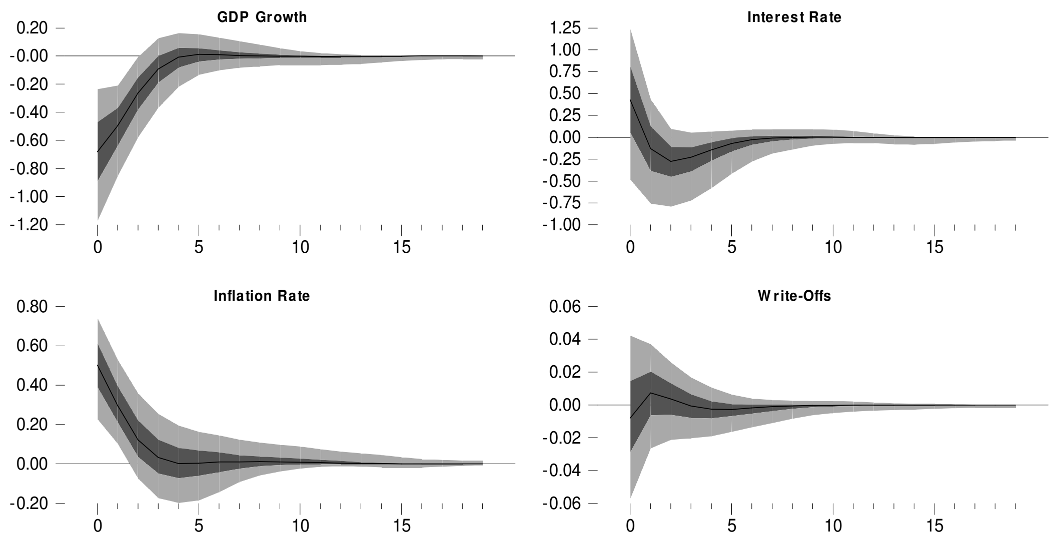
Panel B:



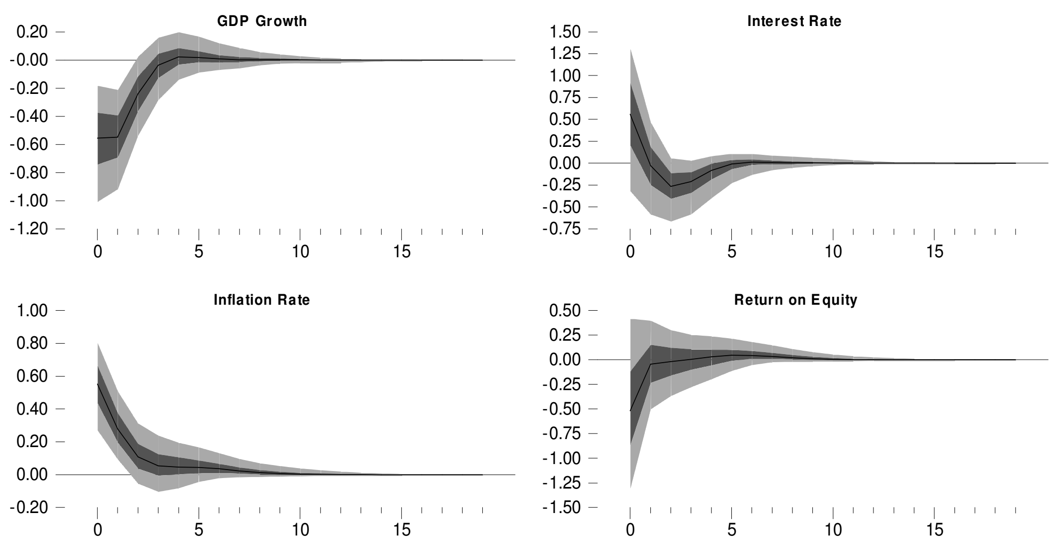
Notes: The figure shows the impulse responses to an adverse aggregate demand shock estimated from two VAR models with four endogenous variables (GDP-Growth, Interest Rate, Inflation, and Write-Offs or Return on Equity respectively) and one exogenous variable (US GDP-Growth). Identification of the structural model is achieved by the sign-restriction approach. The results are based on 10,000 draws in the identification procedure. The black lines indicate the median of the impulses. The two areas of the fan charts represent the 33 percent (dark grey) and 66 percent (light grey) confidence bands respectively. Panel A: Responses in the model with Write-Offs. Panel B: Responses in the model with Return on Equity.

Figure 4: Impulse responses to an adverse supply shock

Panel A:



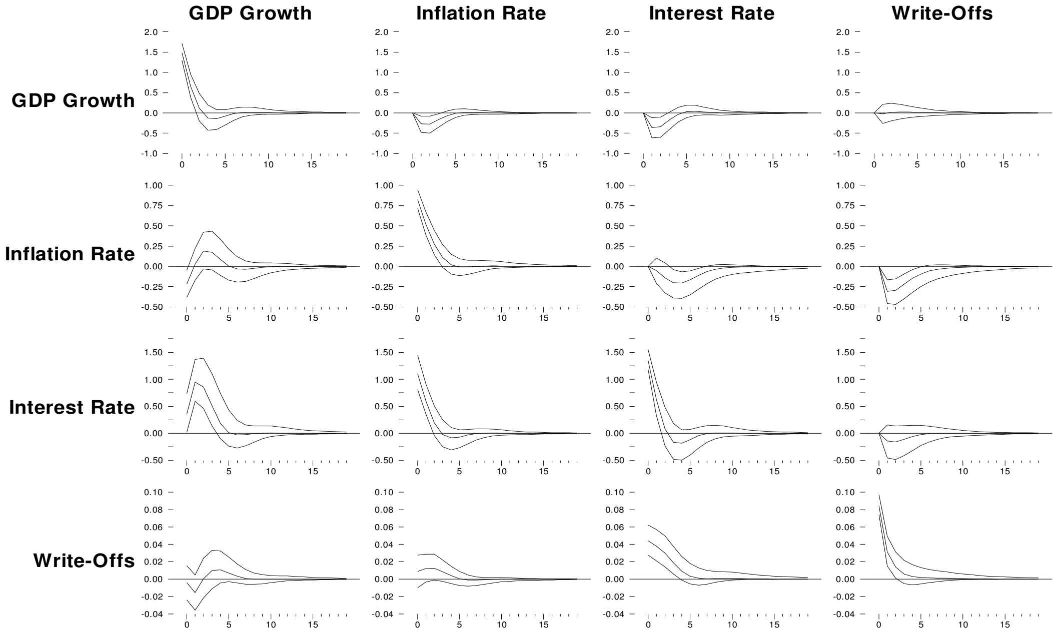
Panel B:



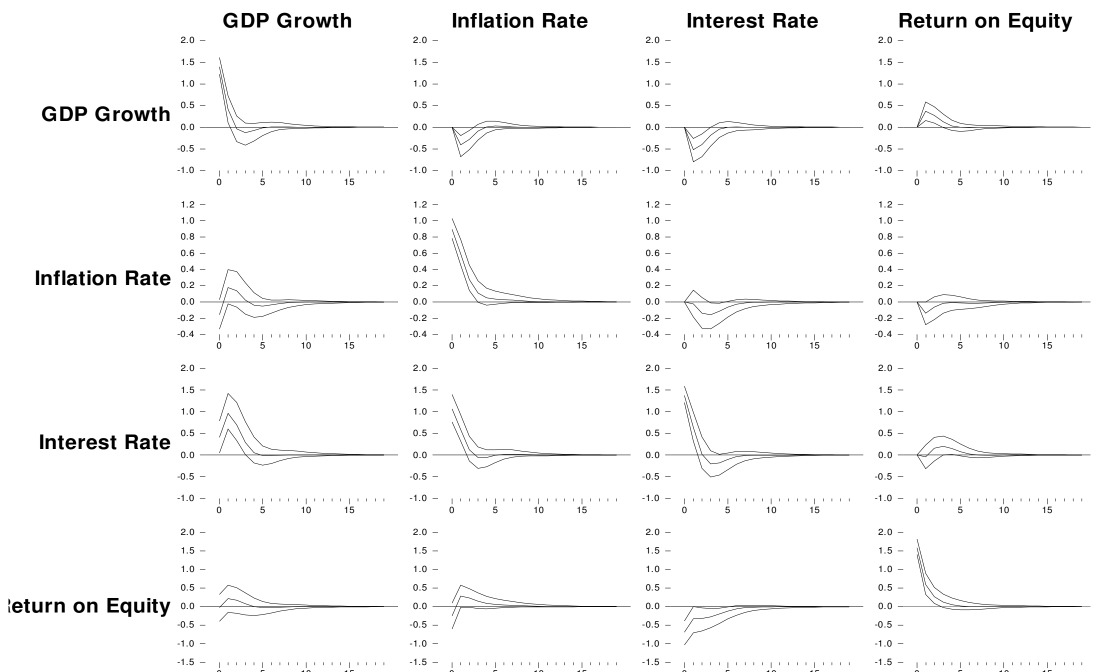
Notes: The figure shows the impulse responses to an adverse aggregate supply shock estimated from two VAR models with four endogenous variables (GDP-Growth, Interest Rate, Inflation, and Write-Offs or Return on Equity respectively) and one exogenous variable (US GDP-Growth). Identification of the structural model is achieved by the sign-restriction approach. The results are based on 10,000 draws in the identification procedure. The black lines indicate the median of the impulses. The two areas of the fan charts represent the 33 percent (dark grey) and 66 percent (light grey) confidence bands respectively. Panel A: Responses in the model with Write-Offs. Panel B: Responses in the model with Return on Equity.

Figure 5: Impulse responses for identification via Cholesky decomposition

Panel A:



Panel B:



Notes: The figure shows the impulse response functions estimated from two VAR models with four endogenous variables (GDP-Growth, Interest Rate, Inflation, and Write-Offs or Return on Equity respectively) and one exogenous variable (US GDP-Growth). Identification of the structural model is achieved via Cholesky decomposition of the covariance matrix of the reduced form model. The results are based on the following ordering of the endogenous variables: GDP-Growth, Inflation, Interest Rate, and Write-Offs or Return on Equity respectively. The central lines indicate the point estimate of the impulses. The outer lines indicate the 66 percent confidence band. Columns refer to the four different structural shocks, rows to the responses of the endogenous variables. Panel A: Responses in the model with Write-Offs. Panel B: Responses in the model with Return on Equity.