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Macroeconomic fluctuations and bank lending: evidence for Germany and the euro area

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Abstract:

This paper analyzes how bank lending to the private nonbank sector responds dynamically to aggregate supply, demand and monetary policy shocks in Germany and the euro area. The results suggest that the dynamic responses in the two areas are broadly similar, although there are some differences in the relative contribution of the three shocks to the development of output, prices, interest rates and bank loans over time. In order to assess the role of bank lending in the transmission of macroeconomic shocks, we perform counterfactual simulations and analyze the dynamic responses of German loan sub-aggregates in order to test the distributional implications of potential credit market frictions. The results suggest that there is no evidence that loans amplify the transmission of macroeconomic fluctuations or that a "financial accelerator" via bank lending exists.

Keywords: Business cycle fluctuations, bank lending, SVAR model, sign restrictions

JEL classification: E32, E44, G21

Non-technical summary

Two related issues form the starting point of our analysis. The first one is the question why the development of bank credit in Germany has differed so much from that in the euro area in recent years. Contrary to the euro area, there was a slowdown in credit growth in Germany and there is an ongoing discussion about the factors that have led to this marked difference. The other issue is the more general question whether bank loans dampen or amplify the effects of macroeconomic shocks. This latter question is closely related to the empirical literature on the "financial accelerator" which faces the – still unresolved – problem of identifying credit demand and credit supply movements.

In order to shed some light on these issues, we analyse how bank lending to the private non-bank sector responds dynamically to macroeconomic shocks in Germany and the euro area. We first estimate the joint dynamic behaviour of real GDP, the price level, the short-term nominal interest rate and the stock of outstanding bank loans using a vector-autoregressive (VAR) model. Based on this model, we identify an aggregate supply shock, a demand shock and a monetary policy shock by imposing short-run sign restrictions on impulse responses. This method has the advantage of being relatively agnostic. It therefore implies a much smaller probability of "creating" certain results by imposing strong *a priori* restrictions than e.g. long-run or zero restrictions, which are often used in the structural VAR literature. We then assess the patterns of the dynamic responses of economic activity, prices, interest rates and bank lending to the three identified macroeconomic shocks as well as the contribution of the three shocks to fluctuations in output, prices, interest rates and bank lending over time based on historical decompositions.

The results suggest that the dynamic response of bank lending to macroeconomic fluctuations in Germany and in the euro area is broadly similar, although there are some differences in the relative contribution of the three shocks to the development of output, prices, interest rates and bank loans over time. Bank lending increases following expansionary shocks, but the responses are very sluggish and only marginally significant. The historical decomposition of the evolution of bank loans reveals that the slowdown in credit creation in Germany in recent years appears to be a realignment of the outstanding stock of loans with its deterministic path, with all three shocks contributing to this development in a very similar way. For the euro area, the strong credit expansion observed over recent years appears to be mainly driven by expansionary demand shocks.

We further assess the role of bank lending in the transmission of macroeconomic shocks based on two different approaches. The first approach is a counterfactual simulation: By switching off the response of bank lending to macro shocks and thus any repercussions on the macroeconomic variables, we try to obtain tentative evidence of the amplifying role of loans in the propagation of macroeconomic shocks at the aggregate level. The second approach analyses the dynamic responses of German loan sub-aggregates in order to test the

distributional implications of potential credit market frictions which form the basis for a possible "financial accelerator". However, the results obtained from both research strategies suggest that there is no evidence that loans amplify the effects of macroeconomic fluctuations.

Nichttechnische Zusammenfassung

Den Ausgangspunkt dieses Papiers bilden zwei miteinander zusammenhängende Fragestellungen. Zum einen untersuchen wir, warum sich die jüngste Entwicklung der Bankkredite in Deutschland deutlich von der im Euro-Währungsgebiet unterschieden hat. Im Gegensatz zum Euroraum kam es in Deutschland zu einer starken Verlangsamung des Kreditwachstums, und es findet eine anhaltende Diskussion darüber statt, welche Faktoren dafür verantwortlich sind. Zum anderen betrachten wir die Frage, ob Bankkredite die Effekte makroökonomischer Schocks abschwächen oder verstärken. Diese Fragestellung ist eng mit der empirischen Literatur über den „Finanzakzelerator" verbunden, deren – weiterhin ungelöstes – Kernproblem die Identifikation von Kreditnachfrage- und Kreditangebotsbewegungen ist.

Vor diesem Hintergrund analysieren wir die dynamische Reaktion der Bankkreditvergabe an den privaten Nichtbankensektor auf verschiedene makroökonomische Schocks in Deutschland und im Euro-Währungsgebiet. Zuerst modellieren wir für die beiden Regionen mithilfe eines vektorautoregressiven (VAR-) Modells das gemeinsame dynamische Verhalten des realen Bruttoinlandsprodukts, des Preisniveaus, des kurzfristigen Nominalzinses und des Bankkreditvolumens. Auf Basis dieses Modells identifizieren wir einen gesamtwirtschaftlichen Angebotsschock, einen Nachfrageschock und einen geldpolitischen Schock, indem wir den Impulsantwortfolgen kurzfristige Vorzeichenrestriktionen auferlegen. Diese Methode hat den Vorteil, relativ agnostisch zu sein. Im Gegensatz etwa zu Nullrestriktionen, die häufig in der Literatur über strukturelle VAR-Modelle verwendet werden, ist die Wahrscheinlichkeit bei dieser Methode geringer, dass bestimmte Ergebnisse durch strenge Annahmen *a priori* „erzeugt" werden. Wir analysieren dann die Reaktionen von realwirtschaftlicher Aktivität, Preisen, Zinssätzen und Bankkreditvergabe auf die drei genannten makroökonomischen Schocks sowie den Beitrag dieser drei Schocks zu den Schwankungen derselben Variablen auf Basis einer historischen Zerlegung.

Die Ergebnisse legen nahe, dass die dynamischen Reaktionen in Deutschland und im Euroraum sehr ähnlich sind, obwohl sich beim relativen Beitrag der drei Schocks zur Entwicklung von realwirtschaftlicher Aktivität, Preisen, Zinssätzen und Bankkrediten im Zeitverlauf einige Unterschiede zeigen. Die Kreditvergabe der Banken nimmt nach expansiven Schocks zu, aber die Reaktionen sind sehr träge und nur marginal signifikant. Die historische Zerlegung der Entwicklung der Bankkredite lässt erkennen, dass die Verlangsamung der Kreditschöpfung in Deutschland in den letzten Jahren als Anpassung des ausstehenden Kreditvolumens an seinen deterministischen Pfad gesehen werden kann, zu der

alle drei Schocks auf ähnliche Weise beigetragen haben. Im Euro-Währungsgebiet scheint die starke Kreditexpansion der letzten Jahre hauptsächlich auf expansive Nachfrageschocks zurückzuführen zu sein.

Die Rolle der Bankkredite bei der Transmission makroökonomischer Schocks wird auf Basis zweier verschiedener Ansätze untersucht. Zum führen wir kontrafaktische Simulationen durch, Dabei schalten wir die Reaktion der Kreditgewährung der Banken auf Makroschocks und damit jegliche Rückwirkungen auf die makroökonomischen Variablen aus, um erste Anhaltspunkte über die verstärkende Rolle von Krediten bei der Übertragung makroökonomischer Schocks auf aggregierter Ebene zu erhalten. Zum andern untersuchen wir die dynamischen Reaktionen deutscher Kredit-Teilaggregate, um die Verteilungswirkungen potentieller Kreditmarktfriktionen, die die Grundlage eines möglichen „Finanzakzelerators“ bilden, zu testen. Die Ergebnisse beider Forschungsansätze geben keine Hinweise auf eine Verstärkung der Transmission makroökonomischer Schwankungen durch Bankkredite.

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Macroeconomic Fluctuations and Bank Lending: Evidence for Germany and the Euro Area*

1. Introduction

Bank loans are the most important external financing source for the private sector in the euro area and its member countries[1] and constitute the largest counterpart to the broad monetary aggregate M3, which plays an important role in the ECB's assessment of medium- to long-run risks to price stability in the euro area. Also, boom and bust cycles in credit markets, often coinciding with asset price bubbles, have in the past often preceded instabilities in financial sectors.[2] Furthermore, new theoretical insights about the implications of asymmetric information in credit markets suggest that bank lending may play an important role in shaping business cycles by propagating shocks and amplifying their impact on the economy.[3] As a result, the monitoring of the development of bank loans and the analysis of its driving forces is an important source of information for the assessment of the future outlook for inflation, economic activity and financial stability.

While there is a large body of literature investigating the role of bank lending in the propagation of monetary policy shocks, there is a general lack of studies that cover its role in the transmission of macroeconomic shocks other than monetary policy. In this paper we aim at filling part of this gap by analyzing the response and role of bank lending in the transmission of supply, demand and monetary policy shocks in Germany and the euro area. The focus on Germany and the euro area is of particular interest in this context because of the divergence in performance between the German economy and the euro-area economy over recent years. While the euro area was characterized by, on average, modest economic expansion and strong credit growth, Germany experienced an unprecedented slowdown in economic activity and bank lending.

The analysis is based on a standard macroeconomic VAR comprising real GDP, the price level, the short-term nominal interest rate and the stock of outstanding bank loans, estimated over the 1985-2005 period. Aggregate supply, aggregate demand and monetary policy shocks are identified using an identification strategy recently proposed by Faust (1998) and Uhlig

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We are grateful to Falko Fecht, Heinz Herrmann, seminar participants at the Deutsche Bundesbank and especially Gert Peersman for helpful discussions.

[1] See Ehrmann et al. (2003).
[2] See e.g. Borio (2002), Borio and Lowe (2002, 2004) and Borio et al. (2003).
[3] See Walsh (2003, Chapter 7) for an overview.

(2005) for monetary policy shocks and extended to other macroeconomic shocks by Peersman (2005), Peersman and Straub (2006) and Canova and De Nicoló (2003), which is based on theoretically motivated short-run sign restrictions on the impulse response functions. We assess the patterns of the responses of economic activity, prices, interest rates and bank lending to the three identified macroeconomic shocks as well as the contribution of the three shocks to fluctuations in output, prices, interest rates and bank lending over time based on historical decompositions.

The effect of the shocks on bank lending is not clear from a theoretical point of view. On the one hand, all three shocks would be expected to have a positive effect on bank lending. A positive aggregate demand shock may cause credit demand to rise as part of an increase in aggregate income or if demand is financed via bank lending. A positive supply shock may also have a positive effect on credit demand, because increased productivity and profitability also stimulate investment and consumption and thereby possibly also the demand for loans.[4] An expansionary monetary policy shock may stimulate credit demand directly by lowering the cost of financing and indirectly via its potentially expansionary effect on economic activity.

As we have already mentioned above, more recent theoretical contributions have stressed that, due to asymmetric information in credit markets, bank lending may also play an active role in business cycle dynamics. In these models, the supply of loans depends on the strength of borrowers' and banks' balance sheets.[5] As a result, via their effect on private sector balance sheets, macroeconomic fluctuations are amplified by procyclical loan supply reactions ("financial accelerator"). Since expansionary macroeconomic shocks will generally have a positive effect on private sector balance sheets, the potential effect of the three macroeconomic shocks on loan supply would be expected to be positive. Thus, a positive reaction of bank loans to macroeconomic shocks may arise from both loan demand and loan supply effects.

However, there are also arguments suggesting that the correlation between the three macroeconomic shocks we consider and bank lending may be negative. Households and firms may want to smooth the effect of such shocks on consumption and investment, e.g. by increasing bank lending after a negative shock. On the other hand, in the case of firms it may

[4] See e.g. Kashyap et al. (1993).

[5] The basic references of this literature are Bernanke and Gertler (1989), Kiyotaki and Moore (1997) and Bernanke et al. (1999). In these models, firms are borrowing constrained because of information asymmetries in the credit market and can only borrow when they offer collateral, so that their borrowing capacity depends upon their net worth. In a recent paper, Aoki et al. (2004) show, based on the model of Bernanke et al. (1999), that a financial accelerator effect also arises in the household sector via house prices when households' ability to borrow depends on the value of housing collateral. Chen (2001) also allows for informational asymmetries between banks and depositors. Just like borrowers' net worth acts as an incentive mechanism and collateral for the banks, bank capital acts in these models as an incentive mechanism and as collateral for the bank's providers of outside funds, the depositors. As a result, macroeconomic shocks are also amplified via bank capital in these models.

also be the case that they adjust the mix between internal and external financing depending on their cash-flow position, increasing the share of internal financing when cash flow is high following expansionary macroeconomic shocks and *vice versa*.[6]

Hence, the question of how macro shocks affect bank lending needs to be resolved empirically. A number of empirical studies have looked at the long-run and short-run effects of economic activity and interest rates on bank lending. The evidence produced by this strand of literature broadly suggests that economic activity is positively correlated with bank lending, while interest rates and bank lending appear to be negatively correlated.[7] In the context of the analysis of the effects of monetary policy shocks on the economy, a number of studies have also looked into the effect of the identified monetary policy shocks. What this literature finds is that an expansionary monetary policy shock is associated with an expansion of bank lending. Thus, on the whole the empirical literature suggests that an expansion of economic activity (driven, for instance, by a positive demand or supply shock) or a reduction of interest rates will have a positive effect on bank lending. However, there is no empirical study yet trying to disentangle the effects of rigorously identified supply, demand and monetary policy shocks.

As we have argued above, a positive response of bank lending to macroeconomic fluctuations may be caused by loan demand, but also loan supply reactions. If the latter were the case, bank lending would potentially not only respond to these shocks, but also play an active, reinforcing role in their transmission. In order to assess the presence and relevance of such potential loan supply effects in the transmission and amplification of macroeconomic shocks, we perform counterfactual simulations based on the estimated VARs. By switching off the response of bank lending to macro shocks and thus any repercussions on the macroeconomic variables, we try to obtain tentative evidence of the amplifying role of loans in the propagation of macroeconomic shocks at the aggregate level.

As such counterfactual exercises at the aggregate have a number of short-comings, we additionally analyze the dynamic responses of loan sub-aggregates in order to test the distributional implications of potential credit market frictions. Due to data unavailability for the euro area, this part of the analysis is confined to German data. We assess whether there are differences in the dynamic response of German sectoral loan aggregates or lending by different German banking groups and whether the differences can be traced back to differences in size. The hypothesis that differences in size of borrows or lenders matter for the effects of macroeconomic fluctuations on bank lending is based on the conjecture that informational frictions and moral hazard problems and thus credit constraints are more relevant for smaller banks and borrowers, as they have to abide less strict and binding

[6] See Bernanke and Gertler (1995) and Friedman and Kuttner (1993).
[7] See e.g. Bernanke and Blinder (1988), Fase (1995), Calza et al. (2001) and Hofmann (2004).

accounting and disclosure rules and have only limited or no access to capital markets for funding their activities. If such considerations are of empirical relevance, lending by smaller banks and lending to smaller firms should react more strongly to macro shocks than lending by/to larger banks and firms.[8] Similar analyses have already been performed by Küppers (2001) and Kakes and Sturm (2002), who focus on the transmission of monetary policy shocks. We extend these studies by also assessing differences in the response of lending across economic sectors and banking groups to aggregate demand and supply shocks.

To summarize, the paper contributes to the literature in the following ways. First, it is the first study to analyze the dynamic effects of the complete set of basic macroeconomic shocks, i.e. an aggregate demand, an aggregate supply and a monetary policy shock, on bank lending. Previous studies focused on the effects of monetary policy shocks and of movements in aggregate economic activity on bank lending without rigorously identifying demand and supply shocks and assessing their impact on bank lending. Second, it is, to our knowledge, the first study to simultaneously analyze differences in the effects of macroeconomic shocks and their contribution to the strikingly divergent developments in credit markets and the overall economy in Germany and the euro area. Third, we extend and update previous studies investigating whether a "financial accelerator" via bank lending is effective in Germany, based on an assessment of differences in the dynamic responses of sectoral loan aggregates and lending of different banking groups to macroeconomic shocks.

The remainder of the paper is organized as follows. Section 2 introduces the data set. Section 3 presents the empirical model and the applied estimation technique. Section 4 provides the empirical results with the impulse response functions to the structural shocks and the historical decompositions. Section 5 investigates the potentially amplifying role of bank lending in the transmission of macroeconomic shocks.. We first present the results of a counterfactual experiment in which possible amplifying effects of loans are "switched off" and then look at the impulse responses of German loan sub-aggregates. Section 6 concludes.

2. Data

We use quarterly seasonally adjusted data for real GDP, the GDP deflator, the three-month money market rate and nominal loans to the private nonbank sector over the 1985Q1-2005Q3 period reported by the Deutsche Bundesbank and the ECB.[9] For Germany, the series for real GDP, the GDP deflator and total loans were linked to the corresponding series for West

[8] See the overview in Walsh (2003, Chapter 7) and the references therein.
[9] The analysis could have been extended back to 1980, but we refrained from doing so as there is evidence that the interlinkages between bank lending and the macroeconomy may have changed in the wake of the deregulation and liberalization of financial systems in the 1970s and early 1980s (Goodhart et al. 2004).

Germany in 1991Q1. The euro-area data for real GDP, the GDP deflator and the short-term nominal interest rate were taken from the ECB database and linked to the corresponding series from the ECB's Area Wide Model (AWM) database in 1995Q1. The seasonally adjusted series for private sector loans from the ECB website was spliced with the series constructed by Calza et al. (2001) in 1991Q1.

The raw series are shown in Figure 1. The graphs illustrate the convergence of nominal interest rates in the euro area in the run-up to EMU in the 1990s, but also the significant divergence in economic performance between the German and the euro-area economies over recent years. While the euro area was characterized by, on average, modest economic expansion and inflation, Germany experienced an unprecedented slowdown in economic activity and very low rates of aggregate price inflation. The differences in bank lending developments over recent years are even more pronounced: While the euro area experienced a strong expansion of bank lending, credit creation came to a virtual standstill in Germany.

3. Methodology

Output, prices, interest rates and loans are collected in the N (= 4)-dimensional vector Y_t. It is assumed that Y_t has a VAR(p) representation:

$$\mathrm{A}(L)\mathrm{Y}_t = \mathrm{Q}\mathrm{v}_t, \tag{1}$$

with $\mathrm{A}(L) = \mathrm{I} - \mathrm{A}_1 L - ... - \mathrm{A}_p L^p$.[10] Unit root tests suggest that all series included in the VAR model contain unit roots. We estimate the VAR in levels since differencing generally leads to the loss of information on long-run relationships between the variables. However, we are interested only in the short-run dynamics and therefore do not consider cointegration between the series.

The matrix Q is chosen such that the innovations v_t are orthonormal. The shocks w_t are related to v_t through the structural equation

$$\mathrm{w}_t = \mathrm{R}\mathrm{v}_t, \tag{2}$$

where $\mathrm{R}'\mathrm{R} = \mathrm{I}_N$. Provided that there are sufficient identifying restrictions on R, the structural shocks w_t can be recovered from the VAR innovations. The $N \times N$ matrix of impulse response functions to the shocks $\mathrm{w}_t = (\mathrm{w}_{1t} \ \ ... \ \ \mathrm{w}_{Nt})'$ at horizon h, $\partial \mathrm{Y}_{t+h} / \partial \mathrm{w}_t' = \Theta_h$ is obtained from

[10] Constants and linear trends are also included.

$$\Theta(L) = \Theta_0 + \Theta_1 L + \Theta_2 L^2 + \ldots = \mathrm{A}(L)^{-1}\mathrm{QR}'. \quad (3)$$

Our ultimate goal is to identify the structural shocks w_t and to assess the impulse responses of the individual variables to these shocks. For this purpose, we fit a VAR(2) model to Y_t. The lag order of the VAR model was determined on the basis of the Akaike criterion. To estimate v_t from the vector of residuals of the fitted VAR, an eigenvalue-eigenvector decomposition is performed, but any other orthogonalization, such as a Cholesky decomposition, would work as well. Let $\hat{v}_t$ denote the resulting vector of orthogonal innovations.

The structural shocks w_t can be recovered from v_t by imposing identifying restrictions which are incorporated in the matrix R. We aim at estimating an aggregate supply shock, an aggregate real demand shock and a monetary policy shock. This is achieved by applying the identification scheme recently proposed by Peersman (2005) which consists of imposing short-run sign restrictions on impulse responses. This method has the advantage of being relatively agnostic, i.e. it implies a smaller probability of "creating" certain results by imposing strong *a priori* restrictions than, for instance, long-run or zero restrictions, which are often used in the structural VAR literature. The latter, in addition, are at odds with some theoretical models (see the discussions in Peersman, 2005 and in Canova and de Nicólo, 2003). The confidence bands were constructed based on bootstrap techniques. More details on the identification of the shocks and the bootstrap are given in the Appendix.

We impose the following restrictions, which are also summarized in Table 1. A positive supply shock has non-negative effects on output and non-positive effects on prices. A demand shock moves output, prices and interest rates in the same direction. An expansionary monetary policy shock does not increase the interest rate and does not lower output and prices.[11] These restrictions are imposed on the contemporaneous and one-quarter ahead reactions of the variables. They are consistent with the standard aggregate supply-aggregate demand framework and with more complex structural models such as the DSGE model developed by Smets and Wouters (2003). Note that, following Farrant and Peersman (2005) and Peersman and Straub (2006), we do not restrict the response of the interest rate to the supply shock, since its sign is not clear *a priori*. On the one hand, a positive supply shock can be expected to reduce nominal interest rates in order to facilitate the alignment of aggregate demand with the increased aggregate supply. On the other hand, Galí et al. (2003) show that, in a forward-looking model, the optimal monetary policy response to a supply shock depends on the persistence of the shock. If the supply shock is highly persistent, expected future income and thus aggregate demand may rise by more than current aggregate supply, so that the optimal monetary policy response may be an increase in the nominal interest rate. Finally,

[11] These are the restrictions also imposed by Farrant and Peersman (2005) and Peersman and Straub (2006) to identify supply, real demand and monetary policy shocks.

we leave the fourth shock in the system unidentified, so that it takes up all variation in the data that is not explained by the three identified shocks.

We do not impose any sign restriction on the response of bank lending. As pointed out in the introduction, the sign of the effect of supply, demand or interest rate shocks on bank lending is not clear from a theoretical point of view, and we want to allow the data to have the complete say on the dynamic response of bank lending.

4. How do macroeconomic shocks affect bank lending?

The identified supply, demand and monetary policy shocks for Germany and the euro area are presented in Figures 2 and 3. On the whole, the shock history of the two economies is broadly similar. The graphs show that, over the EMU period, both Germany and the euro area were affected by a sequence of positive supply shocks in the period 1999-2001, followed (especially in the case of Germany) by a sequence of negative supply shocks. The sequence of demand shocks over this period was broadly balanced in Germany, whereas there have been quite large positive demand shocks in the euro area over the last two to three years. The sequence of monetary policy shocks over recent years is broadly balanced in both areas.[12]

The impulse responses of the four endogenous variables in the VAR to the identified structural shocks are shown in Figures 4 and 5. We report the mean impulse responses and 90% bootstrapped confidence bands. On the whole, the results are broadly similar across shocks and areas. Loans to the non-financial private sector increase after some delay in response to all three shocks. The responses are more persistent in Germany than in the euro area, where, in fact, only the response to the monetary policy shock is marginally significant. The responses of output and prices are broadly in line with the existing evidence (e.g. Peersman 2005). While the effects of a demand shock on output and prices are broadly similar in Germany and the euro area, supply shocks have a stronger impact in Germany and monetary policy shocks are found to have more persistent effects in the euro area. The interest rate responses following the demand and the monetary policy shocks are also in line with the existing evidence, the responses to the supply shock are positive in Germany and the euro

[12] It should be noted in this context that we interpret a monetary policy shock as a deviation of the short-term interest rate from its estimated response to output, prices and the other variables in the VAR. As a result, we obtain different monetary policy shock series for Germany and the euro area, although there was a common monetary policy since the start EMU, and arguably also before the start of EMU with the Bundesbank as the de facto nominal anchor of the European Monetary System. An alternative, stricter view would be to interpret a monetary policy shock as a deviation of interest rates from the estimated reaction function of the monetary authority. We do not follow this approach as it is, in our view, not tractable. In order to avoid mixing up the two monetary regimes before and after 1999, the analysis for Germany would have to be based on a VAR estimated until the end 1998 and the analysis for the euro area would have to be based on a VAR estimated starting in 1999, a sample way to short for VAR analysis.

area. In the latter case, however, the response is not significant, which is in line with the finding by Farrant and Peersman (2005).

The variance decompositions of the five-years ahead forecast errors are reported in Tables 2 and 3. The reported figures state the mean of the relative contribution of each of the three shocks to the forecast error of each of the four variables in the VAR with 90% confidence bands shown in parentheses.[13] The main difference between Germany and the euro area is in the relative importance of the supply and the monetary policy shocks for output, prices and interest rates. In Germany, the supply shock explains a relatively large share of the forecast errors, while the monetary policy shock is relatively unimportant. In the euro area, on the other hand, the contribution of the supply shock to the forecast error variance is smaller, while that of the monetary policy shock is higher. Given the broad similarity of the shock history of the two economies, this result is mainly attributable to the differences in the dynamic effects of supply and monetary policy shocks, the former having stronger effects in Germany and the latter having more persistent effects in the euro area. Interestingly, loans in Germany are mainly driven by demand shocks, which explain more than one-third of the forecast error,[14] yet the role of supply and monetary policy shocks, which account for 23% and 22%, respectively, of the loans' variation, is not negligible, either. For the euro area, all three shocks have similar explanatory power with variance shares ranging from 24% to 29%.

In order to assess the driving forces of the dynamic evolution of the four variables under investigation, especially over the more recent time period, we present in Figures 6 and 7 the historical decomposition of the four time series included in the VAR. The figures show the contributions of the individual shocks to the accumulated forecast error of each variable. The graphs reveal that the recent weak economic performance of Germany was primarily driven by adverse supply shocks and, albeit to a lesser extent, also adverse demand and monetary policy shocks. On the other hand, the low inflation rates observed over the last couple of years were mainly the effect of adverse demand and monetary policy shocks, while the adverse supply shocks which held down output actually had a price-increasing effect. The historical decomposition of the evolution of bank loans reveals that the slowdown in credit creation over the last few years may actually be regarded as a realignment of the outstanding stock of loans with its deterministic level, with all three shocks contributing to this development in a very similar way.

For the euro area, the historical decompositions suggest that the dynamic evolution of output, prices, interest rates and loans was also to a large extent shaped by the effect of supply shocks, also because demand and monetary policy shocks had mutually offsetting effects. Since the start of EMU, the effects of monetary policy shocks have been expansionary, while

[13] Focusing on the median instead of the mean does not yield qualitatively different results.
[14] In this paper, we focus on the 5-years ahead forecast error. Variance decompositions for shorter forecast horizons are available upon request.

the effects of aggregate demand shocks have been adverse. More recently, however, this pattern has changed, with monetary policy shocks becoming less expansionary or even turning contractionary and demand shocks turning expansionary. In particular, the more recent credit expansion in the euro area appears to be driven mainly by expansionary demand shocks.

5. Testing for loan supply effects

5.1. A counterfactual experiment

Based on the estimated VARs, we can obtain tentative evidence regarding the relevance of systematic bank loan supply effects based on counterfactual simulations which switch off the shock response of bank lending and thereby any repercussions on the macroeconomic variables in the system. In principle, an amplification of shocks may only arise as a consequence of loan supply reactions, but not of passive loan demand reactions. It therefore appears possible to detect the presence or absence of loan supply effects by comparing the unconstrained impulse responses of the other macro variables in the system, in particular real GDP, with the impulse response when the response of loans, and thus any repercussions thereof on the other variables, is switched off.[15]

In order to switch off the potential amplifying effects of bank loans, we set all elements in the row of QR' which refers to the loan equation in the VAR model to zero while keeping the remaining coefficients fixed (thus setting the effects of the structural shocks on loans and therefore the impact of changes in loans on the macro variables to zero). Figure 8 shows the differences between the unconstrained and the resulting counterfactual impulse response functions. They indicate a positive, but statistically insignificant contribution of lending to the spread of macro shocks throughout the German economy. A similar conclusion can be drawn for the euro area (Figure 9). In the euro area, loans also appear to play no active role in the response of output and prices. Only the monetary policy reaction to macro shocks appears to be significantly affected by loans: the difference between the unconstrained and counterfactual impulse responses of short-term interest rates becomes marginally significant for a few quarters after roughly two years, indicating a significant response of interest rate to loan movements.

[15] This approach to assess the relevance of credit supply effects has also been adopted by Ashcraft (2006) and Deutsche Bundesbank (2005). For similar counter-factual experiments to detect the role of systematic monetary policy see Bernanke et al. (1997) and Sims and Zha (1998).

However, it should be noted that there are a number of caveats associated with this approach. In particular, the counterfactual experiment is not immune against the Lucas critique: changes of private sector expectations of the policy process that may result from policy changes and may alter the parameters of the model are not accounted for. Also, as has already been stressed by Bernanke (1993), even if no amplifying role of loans were found, this would not necessarily imply that loans play no role, as its explanatory power may have been absorbed by other variables reflecting the monetary stance, in our case the interest rate. On the other hand, if loans were found to play a significant role in shaping the dynamic responses of the other variables, this may not necessarily imply that there are loan supply effects, as it may potentially also reflect loan demand reactions to anticipated future movements in output.

5.2. An analysis based on disaggregated German data

"Financial accelerator" effects via bank lending are generally difficult to detect in reduced-form macro models such as the VAR we analyzed in the previous sections, because they are observationally equivalent to the effects caused by other transmission channels.[16] In particular, as we have discussed above, the observed responses of aggregate bank lending to macroeconomic shocks can be due either to loan demand responses, loan supply responses, or both. For this reason, the bulk of the empirical literature attempts to detect loan supply effects indirectly by testing the distributional implications of credit market imperfections. As we have already discussed in the introduction, informational frictions should fundamentally be more relevant for small borrowers and banks, which is a testable hypothesis.

There are a large number of studies testing this hypothesis using disaggregated data for individual banks or firms using panel estimation techniques. For the US, Gertler and Gilchrist (1993, 1994), for instance, present evidence suggesting that bank loans are shifted from small to large firms when monetary policy is tightened, while Kashyap and Stein (1995, 2000), among other, find that lending by small banks contracts more sharply than lending by large banks after a monetary contraction. For the euro-area countries, the role of banks in the transmission of monetary policy shocks has been analyzed in depth in the Eurosystem "Monetary Transmission Network" (MTN).[17] The MTN studies found no evidence that the response of bank lending depends on the size or the capitalization of banks and thus little support for the hypothesis of a "financial accelerator" via bank lending. For some euro area countries, especially Germany, this finding is attributed to close interbank links and networks

[16] See, for example, Cecchetti (1995).
[17] The complete set of studies produced by the MTN is published in Angeloni et al. (2003).

and close, long-term relationships between borrowers and lenders, which mitigate loan supply effects potentially arising from informational frictions in the credit market.[18]

The use of disaggregated individual bank data is not an option here: the sample period for which these data are available is too short for a reasonable time series analysis.[19] An alternative approach to test the relevance of "financial accelerator" effects using time series techniques is to test for differences in the responses of loan sub-aggregates. This is the approach we pursue in the following. However, due to data unavailability for the euro area, the analysis is confined to Germany.

The German banking sector is characterized by the coexistence of various types of banks with rather different characteristics. The broadest distinction can be made between universal banks, which offer a broad range of services, and specialized banks such as mortgage banks and development banks. In the following, we focus on the universal banking sector, which accounts for about 75% of the German banking sector in terms of total assets and for about 80% of outstanding loans to the private nonbank sector.[20] The universal banking sector is composed of three pillars: the commercial banking sector, the savings banks sector and the credit cooperative sector. The commercial banking sector is privately owned and comprises the five big banks (Großbanken),[21] the regional banks (Regionalbanken), and the branches of foreign banks. The savings banks sector is publicly owned and consists of the savings banks (Sparkassen) and the Landesbanks (Landesbanken), which act as clearing banks for the savings banks. Finally, the credit cooperative sector is based on the principle of mutuality and comprises the credit cooperatives (Kreditgenossenschaften) and the cooperative central banks (Girozentralen), which also act as clearing banks for the credit cooperatives.

Table 4 presents some descriptive statistics on the different banking groups which were current at the end of 2005. We report for each banking group the number of institutions, the total assets, total lending to private nonbanks and the average size, defined as total assets divided by the number of institutions. The figures suggest that the banking groups and also each of the three pillars are characterized by substantial heterogeneities in terms of size. With an average size of more than €100 million, the big banks, Landesbanks and cooperative central banks are substantially larger than the regional banks (€3,800 million), the savings banks (€2,200 million) and, in particular, the credit cooperatives (€457 million). According to the size hypothesis, lending by the former three banking groups should respond more weakly to macroeconomic shocks than lending by the latter three banking groups.

[18] See Ehrmann et al. (2006) and also Ehrmann and Worms (2004) and Hofmann and Worms (2006).
[19] The individual bank data for Germany used in the MTN study by Worms (2004) start in 1993.
[20] In 2005, total assets of all MFIs were €6,903 billion of which universal banks accounted for €5,128 billion (Deutsche Bundesbank, 2006, Table I.3). The figures for outstanding loans to the private nonbank sector are €2,226 billion for all MFIs and €1,777 billion for the universal banks.
[21] The five big banks are Deutsche Bank, Dresdner Bank, Commerzbank, Hypovereinsbank and Postbank.

Küppers (2001) and Kakes and Sturm (2002) analyze whether there is a "financial accelerator" of monetary policy shocks via bank loans ("bank lending channel"). Both studies are based on a VAR framework using data starting in the late 1960 or mid-1970s and ending in the mid/late 1990s. Differences in the responses of lending by different banking groups are assessed by estimating separate VARs for each banking group. However, the two studies fail to come to consistent conclusions. While Küppers finds no evidence of bank lending channel effects in Germany, Kakes and Sturm conclude that their results provide support for the existence of a bank lending channel.

We also try to test the size hypothesis on the borrower's side by assessing differences in the response of lending to different sectors of the economy, differentiating between enterprises, households and self-employed persons.[22] Although no balance sheet data exist to demonstrate differences in size formally, it seems reasonable to conjecture that self-employed persons and households are smaller and also more limited in their access to nonbank sources of finance, which would imply that lending to them should respond more strongly than lending to enterprises if credit frictions are relevant. Küppers (2001) also tests for differences in the response of lending to households and to firms, but finds that the result depends on the specification of the VAR model, in particular whether both sectors are included in a single VAR or whether separate VAR models are estimated for each sector.

Given the inconclusiveness of the existing evidence, there seems to be scope for a reassessment of these issues for an updated sample. In the following, we investigate whether impulse responses of lending by different German banking groups and lending to different types of borrowers is heterogeneous and whether the differences, if any, can be associated with differences in size. In contrast to the existing evidence, which focuses exclusively on the transmission of monetary policy, our framework also allows us to assess differences in the dynamic effects of aggregate demand and supply shocks. We also attempt to improve on some shortcomings of the earlier studies. First, our sample period (1985-2005) keeps the disinflation of the early 1980s from affecting the estimation results.[23] Second, in order to keep the structural shocks invariant to the inclusion of loan sub-aggregates in the analysis, we follow Peersman and Smets (2003) and respectively add one loan sub-aggregate to the baseline VAR as a block-exogenous variable. If we estimated a separate VAR for each loan sub-aggregate instead, each VAR would yield a different set of shocks, so that the impulse responses would not be directly comparable.

[22] Self-employed persons include sole proprietors, persons conducting (small) businesses, members of the professions, farmers, and persons whose income is derived chiefly from their assets (Deutsche Bundesbank, 2003).

[23] Admittedly, in return, we catch another caveat due to the start of EMU in 1999 with the handover of monetary control from the Bundesbank to the European Central Bank. If one aims at exploiting times series observations up to the present, however, this is an inevitable problem which also applies to other studies; Peersman (2005), for example, also carries out his VAR analysis for the euro area based on a period covering the two monetary policy regimes.

The analysis is therefore performed by extending the baseline model analyzed above to read as follows:

$$\begin{bmatrix} \mathrm{A}(L) & 0 \\ \mathrm{B}(L) & \mathrm{C}(L) \end{bmatrix} \times \begin{bmatrix} \mathrm{Y}_t \\ Z_t \end{bmatrix} = \begin{bmatrix} \mathrm{QR'w}_t \\ \alpha' \mathrm{w}_t + \tilde{u}_{zt} \end{bmatrix}, \tag{4}$$

where Z_t denotes a certain loan sub-aggregate and is a scalar, $\mathrm{B}(L) = 1 - \mathrm{B}_1 L - ... - \mathrm{B}_p L^p$ and $\mathrm{C}(L) = 1 - \mathrm{C}_1 L - ... - \mathrm{C}_p L^p$ determine the extent to which the loan aggregate is affected by the lags of the variables included in our baseline model and its own lags. The instantaneous impacts of the structural shocks w_t are given by the N-dimensional vector α, and $\tilde{u}_{zt}$ denotes the reduced form residual of the Z_t-equation after removing the impact of w_t.

We start by investigating differences in the responses of lending by the different banking groups. The results are reported in Figure 10. We do not report results for the branches of foreign banks and the cooperative central banks, as these two groups account for only a negligible share of total lending business.[24] For comparison, we also show the impulse response of total bank loans in each graph.[25] The graphs reveal that lending by the big banks responds more strongly to macroeconomic shocks, in particular to supply and monetary policy shocks, whereas lending by regional banks and, to a lesser extent, also credit cooperatives, savings banks and Landesbanks responds somewhat more weakly than aggregate lending. Thus, there is no evidence that lending by banking groups characterized by smaller average institution sizes responds more strongly to shocks than aggregate lending. This result is consistent with the findings of Küppers (2001).

Next we assess whether there are differences in the impulse responses of loans to households, enterprises and self-employed persons. The results are reported in Figure 11. The graphs suggest that lending to households responds to a somewhat weaker extent to macroeconomic shocks than lending to the other two sectors. Lending to self-employed persons responds somewhat more strongly than lending to enterprises about one year after the shock. However, the differences are not statistically significant. Thus, there is also no strong evidence that the borrowers' size affects how their borrowing responds to macroeconomic shocks.

Finally, we also perform a combined test of the size hypothesis by investigating the impulse response of lending by the different banking groups to the three different types of borrowers. The results are displayed in Figures 12-14. The results again do not support the size hypothesis: they do not confirm that lending by smaller credit institutions, i.e. regional banks, savings banks and especially credit cooperatives, to smaller firms, i.e. self-employed persons, responds more strongly to macroeconomic shocks than aggregate loans.

[24] The results are, however, available upon request.
[25] We also computed confidence bands for the differences between responses of sub-aggregates and the benchmark. Those are not reported here, but available upon request.

6. Conclusions

This paper analyzes the dynamic response of aggregate bank lending to the private nonbank sector to aggregate supply, demand and monetary policy shocks in Germany and the euro area. The results suggest that the dynamic responses in the two areas are broadly similar. Bank lending increases following expansionary shocks, but the responses are very sluggish and only marginally significant. The historical decomposition of the evolution of bank loans reveals that the slowdown in credit creation over the last years may actually be seen as a realignment of the outstanding stock of loans with its deterministic level, with all three shocks contributing to this development in a very similar way. For the euro area, the strong credit expansion observed over recent years appears to be mainly driven by expansionary demand shocks.

In order to assess the role of loans in the transmission and amplification of macroeconomic shocks, we perform counterfactual simulations and analyze the dynamic responses of German loan sub-aggregates in order to test the distributional implications of potential credit market frictions. The results suggest that there is no evidence that loans significantly amplify the transmission of macroeconomic fluctuations. The weak evidence regarding the importance of a generalized "financial accelerator" via bank lending in Germany and the euro area may both be attributed to close interbank links and networks and close, long-term relationships between borrowers and lenders (*Hausbankenprinzip*), which mitigate the effect of macroeconomic fluctuations on bank lending and the role of credit market frictions (Ehrmann et al. 2003, Worms 2004).

With evidence of "financial accelerator" effects already weak to begin with, recent developments in euro-area banking sectors and capital markets point to a further weakening of any such effects.[26] The growing importance of corporate bond markets improves the funding opportunities of non-financial corporations and reduces their dependence on bank loans. The improved funding opportunities for banks in the wake of the dynamic development of securitization markets in the euro-area countries in recent years is another noteworthy development that may matter in this context. Securitization enables financial institutions to transform their illiquid assets, such as loans, into tradable securities. The ability to securitize loans gives financial institutions access to additional funding sources, so that their funding ability is less likely to be constrained in the event of an adverse macroeconomic shock. As a result, a possible "financial accelerator" effect via bank lending is also likely to lose importance as securitization markets continue to evolve.[27]

[26] See e.g. Hofmann and Worms (2006) and the references therein.
[27] Estrella (2002) finds that the weakening of the effects of monetary policy on economic activity in the US can be related to rising securitization since the 1960s.

On the other hand, however, it is often conjectured that the close borrower-lender relationships, which have been emphasized above as one potential explanation for the sluggish response of lending to macroeconomic fluctuations and the weak evidence of the existence of a "financial accelerator" via bank lending in Germany and the euro area, could become less important in the future if the financial system becomes more market-oriented,[28] which might partly offset the direct effects of improved funding opportunities described earlier.

[28] See e.g. Elsas and Krahnen (2003).

Appendix

The rotation matrix R has to be chosen such that the identifying restrictions specified above are satisfied. Any four-dimensional rotation matrix can be parameterized as follows

$$\mathrm{R}(\theta_1,\theta_2,\theta_3,\theta_4) = \begin{pmatrix} \cos(\theta_1) & -\sin(\theta_1) & 0 & 0 \\ \sin(\theta_1) & \cos(\theta_1) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \times \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos(\theta_2) & -\sin(\theta_2) & 0 \\ 0 & \sin(\theta_2) & \cos(\theta_2) & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \times \tag{A1}$$

$$\begin{pmatrix} \cos(\theta_3) & 0 & -\sin(\theta_3) & 0 \\ 0 & 1 & 0 & 0 \\ \sin(\theta_3) & 0 & \cos(\theta_3) & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \times \begin{pmatrix} \cos(\theta_4) & 0 & 0 & -\sin(\theta_4) \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ \sin(\theta_4) & 0 & 0 & \cos(\theta_4) \end{pmatrix} \times$$

$$\begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos(\theta_5) & 0 & -\sin(\theta_5) \\ 0 & 0 & 1 & 0 \\ 0 & \sin(\theta_5) & 0 & \cos(\theta_5) \end{pmatrix} \times \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & \cos(\theta_6) & -\sin(\theta_6) \\ 0 & 0 & \sin(\theta_6) & \cos(\theta_6) \end{pmatrix}.$$

To systematically explore the shock space, we vary the rotation angles θ_1, θ_2, θ_3, θ_4, θ_5 and θ_6 between 0 to π and fix them so that the imposed restrictions are satisfied. For a reasonably large number of grids, more than one rotation satisfies our restrictions. We give equal probability to all of them and, in this case, draw and keep one randomly.[29]

In order to account for the uncertainty involved with the estimation of the VAR model, we construct confidence bands by means of the bootstrap-after-bootstrap techniques based on Kilian (1998). These techniques allow us to remove a possible bias in the VAR coefficients which can arise due to the small sample size of the VAR model (for details on the bootstrap see Kilian 1998). Most draws deliver not just one, but a set of shocks which all satisfy the restrictions. In this case, we follow Peersman (2005) and draw and save one of them. Some draws, however, do not deliver any shocks satisfying the restrictions. We draw until we have saved 500 shocks, which required 11515 draws for Germany and 2616 draws for the euro area.[30]

[29] In this case, Canova and de Nicoló (2003), who apply a similar identification scheme, suggest imposing more restrictions, which allows us to fix only one rotation. We decide not to do so. One reason is that we do not focus on the point estimates but on the (mean of the) bootstrapped impulse responses and confidence bands. For each draw, a different number of rotations satisfying the restrictions may arise. Imposing more restrictions in order to get one single point estimate therefore would not help much.

[30] For more details on the identification, the reader is referred to Peersman (2005).

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Table 1: Sign restrictions

	Output	Prices	Interest rates	Loans
Supply shock	↑	↓	?	?
Demand shock	↑	↑	↑	?
Monetary policy shock	↑	↑	↓	?

Note: Output is real GDP, prices the GDP deflator, interest rates the three-month money market rate and loans are nominal private loans. Restrictions are imposed contemporaneously and on the first quarter after the shock. "?" indicates no restriction.

Table 2: Variance decomposition of German forecast errors

	Supply shock	Demand shock	Monetary policy shock
Output	0.52 (0.16 - 0.81)	0.21 (0.03 - 0.55)	0.14 (0.02 - 0.32)
Prices	0.30 (0.08 - 0.60)	0.40 (0.13 - 0.72)	0.13 (0.02 - 0.35)
Interest rates	0.49 (0.16 - 0.76)	0.24 (0.04 - 0.54)	0.13 (0.04 - 0.25)
Loans	0.23 (0.02 - 0.59)	0.35 (0.06 - 0.73)	0.22 (0.02 - 0.51)

Note: Output is real GDP, prices the GDP deflator, interest rates the three-month money market rate and loans are nominal private loans. The forecast horizon is 5 years. The mean and the 90% confidence bands are shown.

Table 3: Variance decomposition of euro-area forecast errors

	Supply shock	Demand shock	Monetary policy shock
Output	0.28 (0.04 - 0.65)	0.24 (0.03 - 0.61)	0.32 (0.03 - 0.73)
Prices	0.15 (0.02 - 0.42)	0.37 (0.05 - 0.73)	0.29 (0.03 - 0.64)
Interest rates	0.25 (0.03 - 0.55)	0.30 (0.05 - 0.58)	0.27 (0.03 - 0.55)
Loans	0.29 (0.03 - 0.66)	0.24 (0.02 - 0.64)	0.24 (0.03 - 0.59)

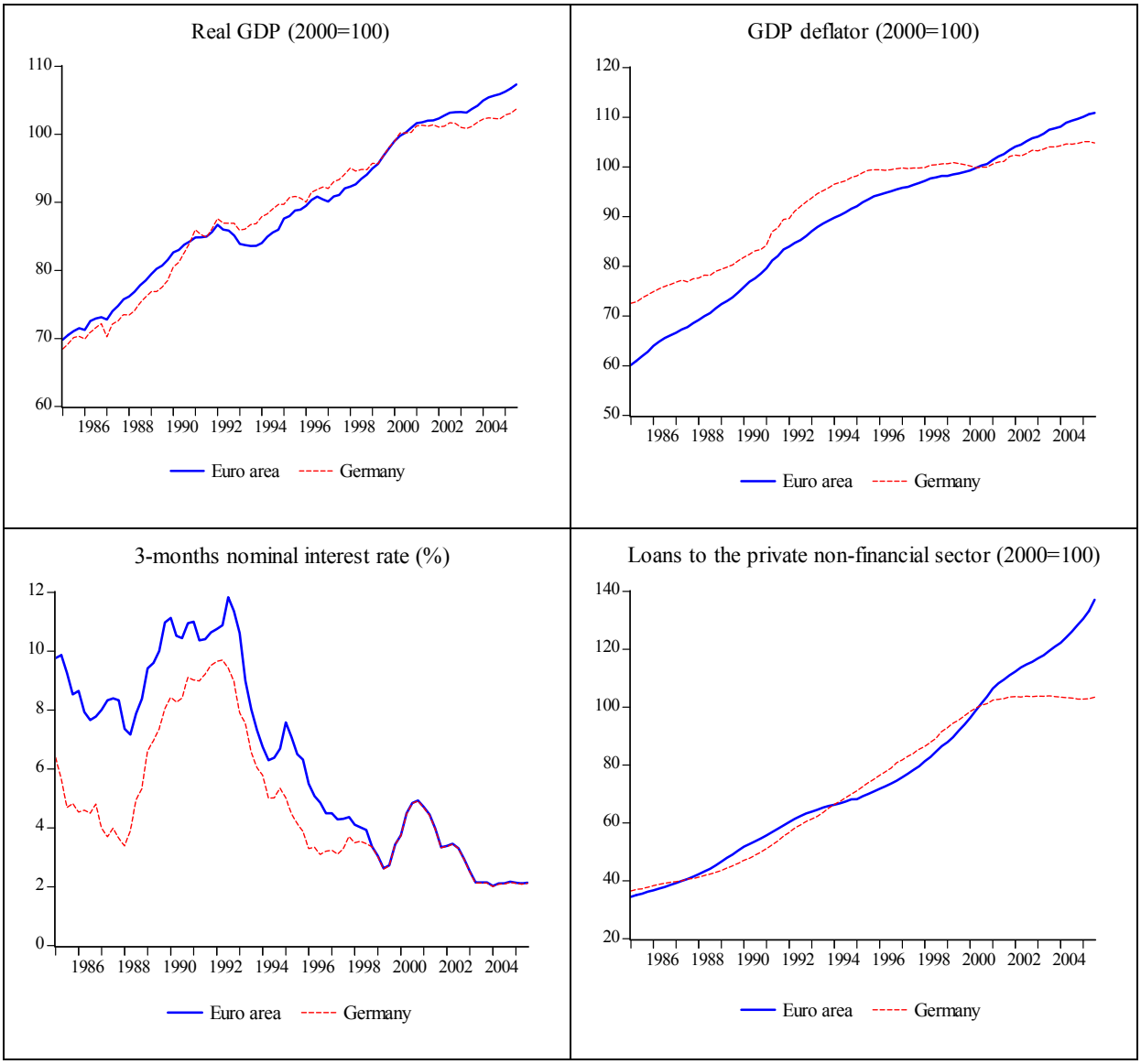
Note: Output is real GDP, prices the GDP deflator, interest rates the three-month money market rate and loans are nominal private loans. The forecast horizon is 5 years. The mean and the 90% confidence bands are shown.

Table 4: The German banking groups in 2005

	Number of institutions	Total assets	Loans to private nonbanks	Average size
Big banks	5	1,226,940	314,530	245,388
Regional banks	158	602,932	232,315	3,816
Branches of foreign banks	89	103,344	32,222	1,161
Landesbanks	12	1,365,045	258,256	113,754
Savings banks	463	1,013,955	574,053	2,190
Cooperative central banks	2	224,702	18,201	112,351
Cooperative banks	1,294	591,886	347,852	457

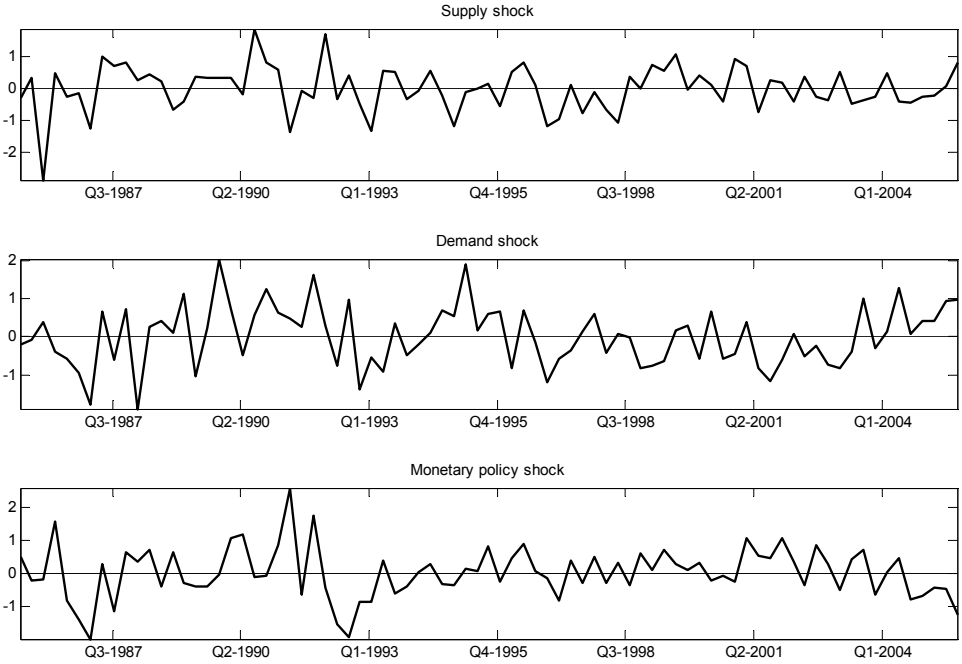
Note: Total assets, loans to private nonbanks and average size are in € million. The average size is defined as total assets divided by number of institutions. Source: Deutsche Bundesbank (2006).

Figure 1: Raw data for the empirical analysis, euro area and Germany 1985Q1-2005Q3



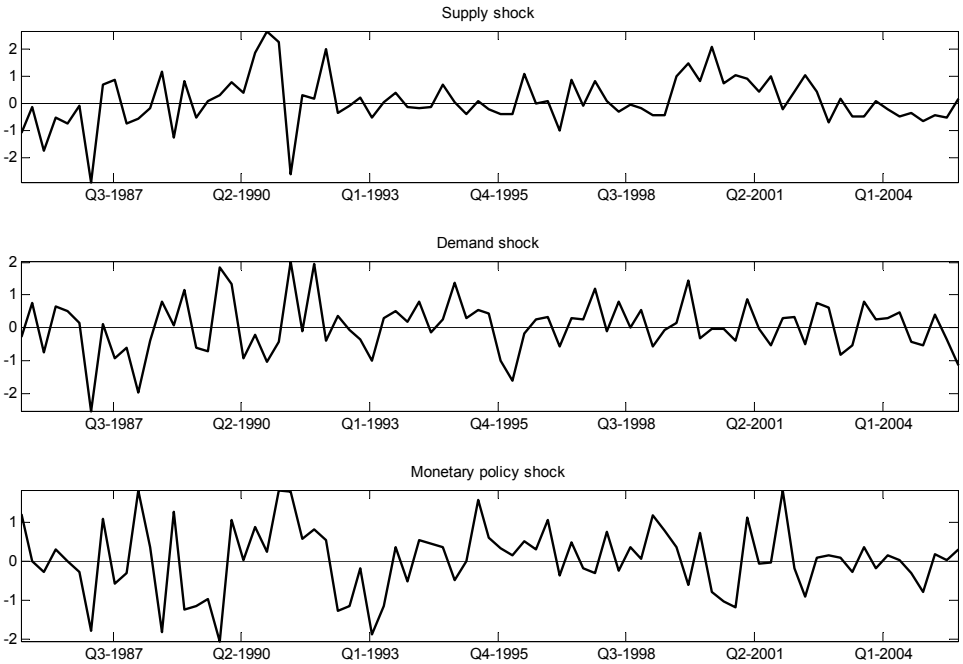
Note: All data are seasonally adjusted except for the nominal interest rates. Sources: ECB and Deutsche Bundesbank.

Figure 2: German shock series



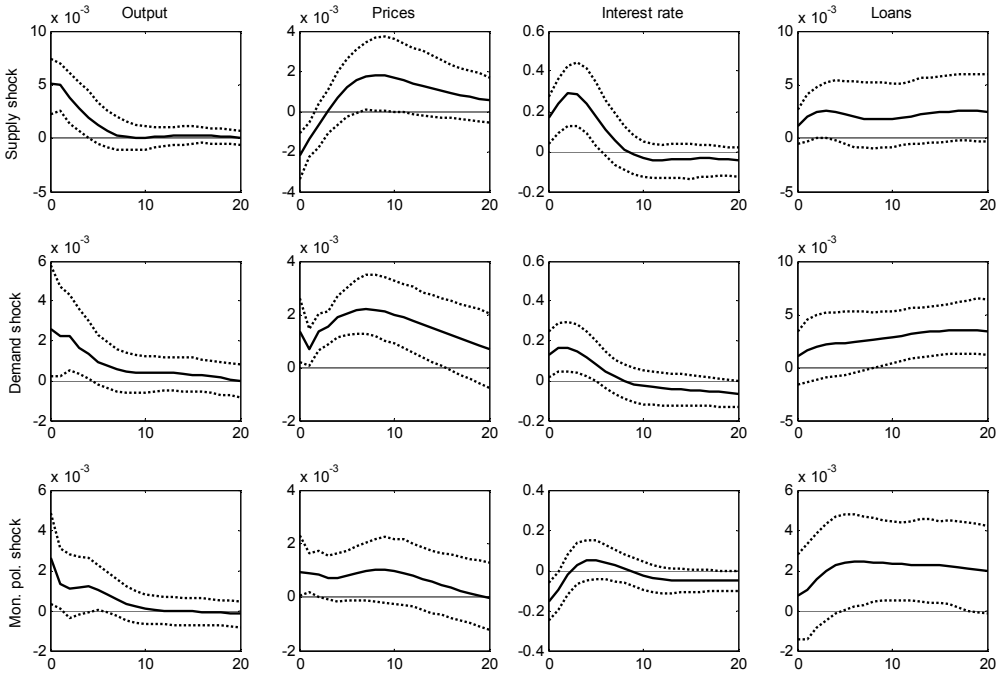
Note: Mean point estimates (after having randomly drawn rotation angles between 0 and π until 500 draws which satisfied the identifying restrictions were saved.)

Figure 3: Euro-area shock series



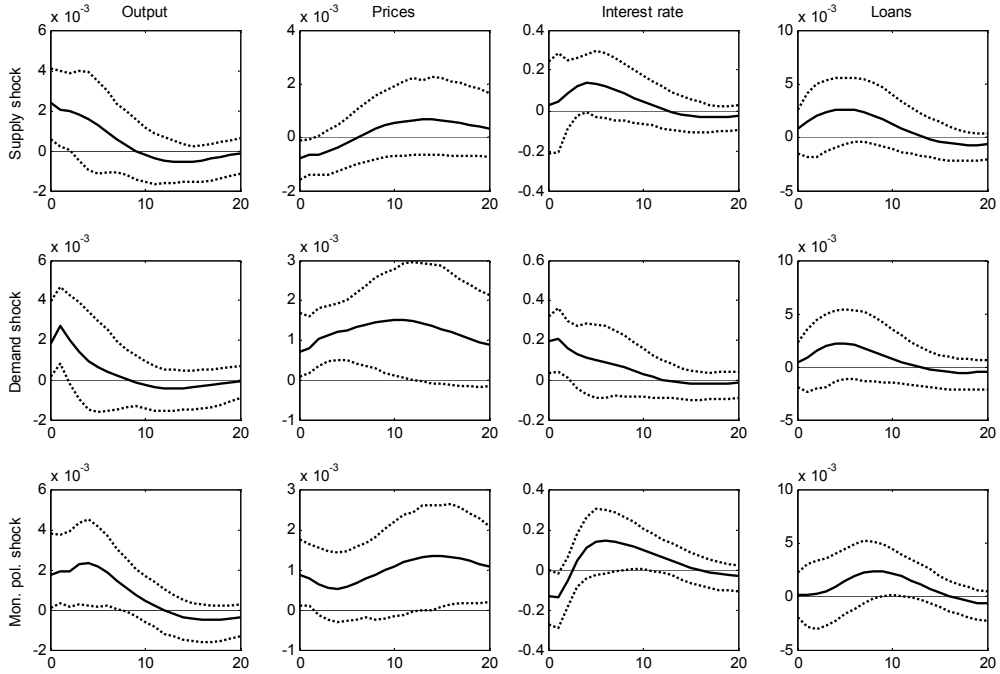
Note: Mean point estimates (after having randomly drawn rotation angles between 0 and π until 500 draws which satisfied the identifying restrictions were saved.)

Figure 4: German impulse responses



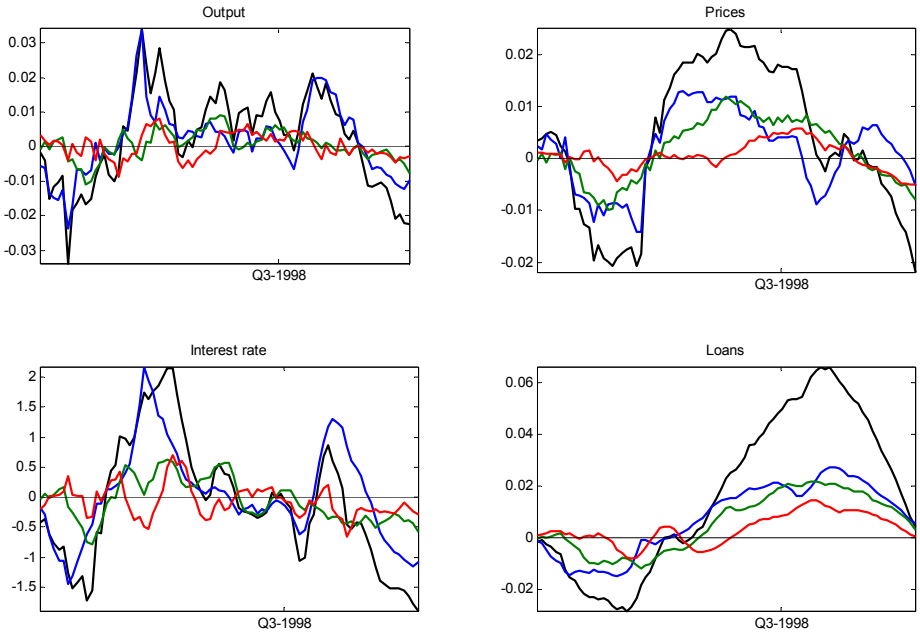
Note: Impulse responses to shocks of one standard deviation in size. Mean: solid, 90% confidence bands: dotted. Output is real GDP, prices the GDP deflator, interest rates the three-month money market rate and loans are nominal private loans.

Figure 5: Euro-area impulse responses



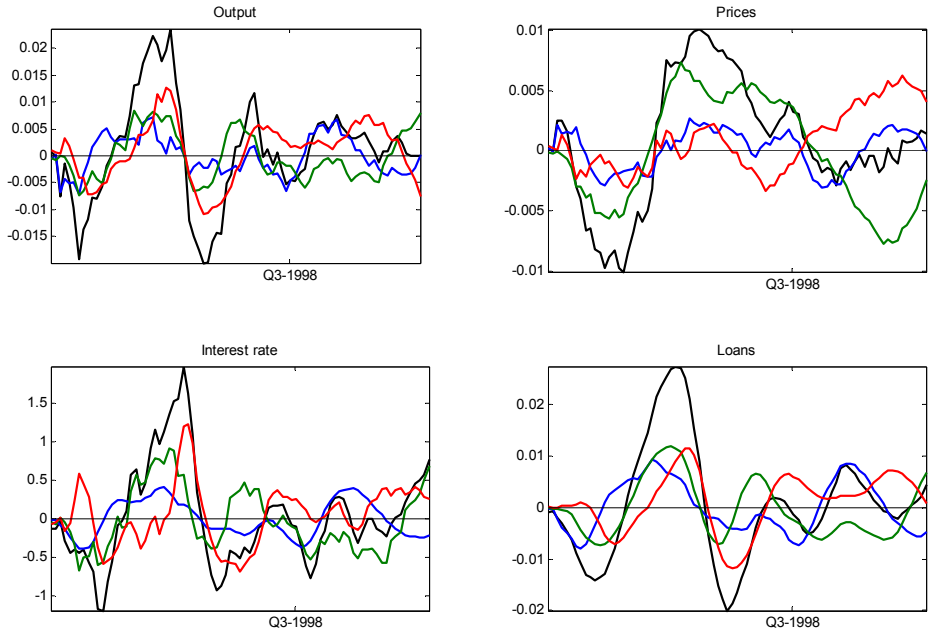
Note: Impulse responses to shocks of one standard deviation in size. Mean: solid, 90% confidence bands: dotted. Output is real GDP, prices the GDP deflator, interest rates the three-month money market rate and loans are nominal private loans.

Figure 6: Historical decomposition for Germany



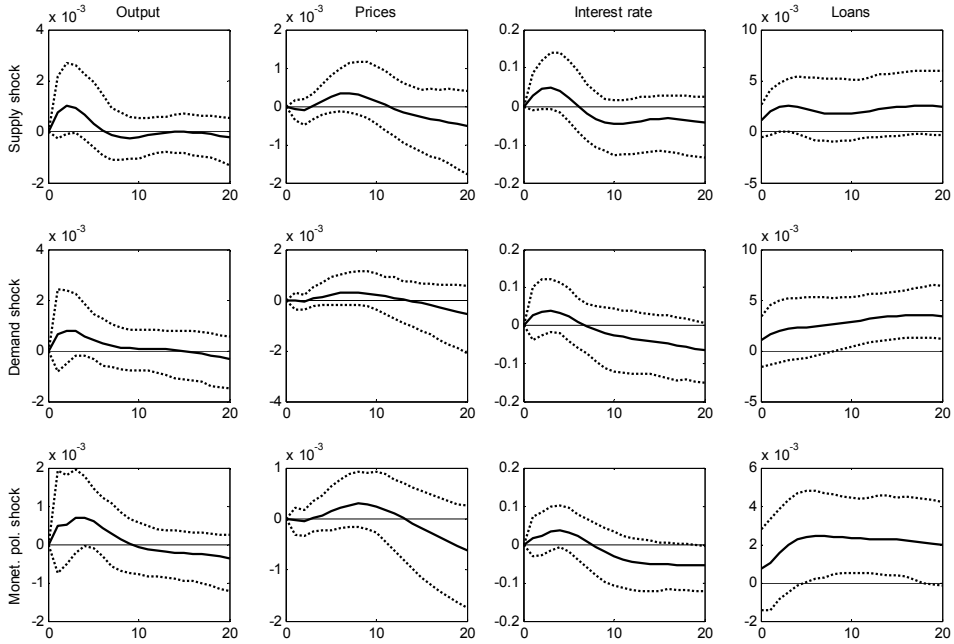
Note: Total forecast error (black), forecast error explained by the supply shock (blue), the demand shock (green) and the monetary policy shock (red). The historical decomposition is based on the mean point estimates of the structural shocks and on cumulated impulse responses. The forecast horizon is 0 for the first observation, 1 for the second, ... and T-1 for the last observation.

Figure 7: Historical decomposition for the euro area



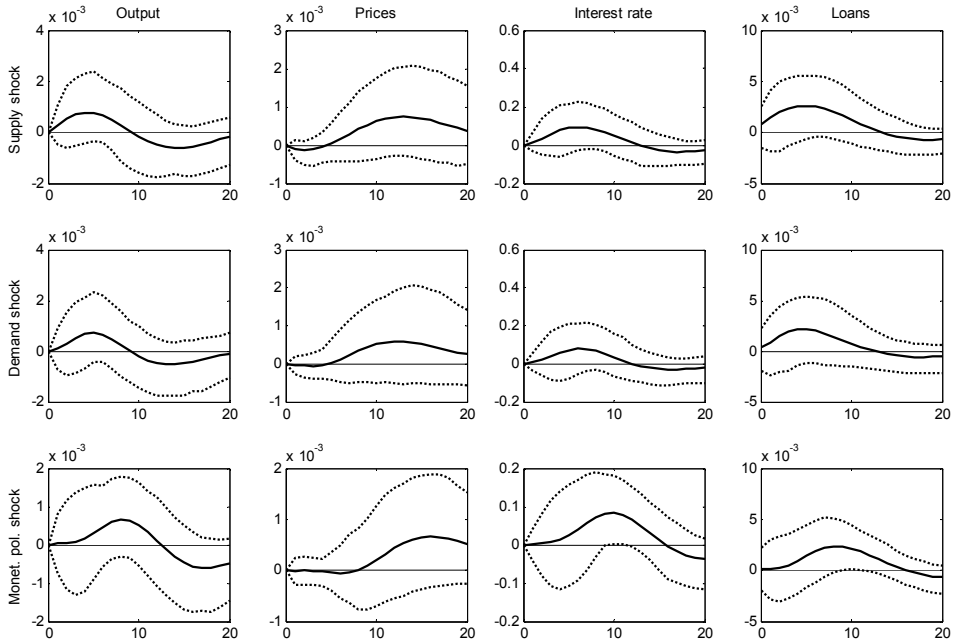
Note: Total forecast error (black), forecast error explained by the supply shock (blue), the demand shock (green) and the monetary policy shock (red). The historical decomposition is based on the mean point estimates of the structural shocks and on cumulated impulse responses. The forecast horizon is 0 for the first observation, 1 for the second, ... and T-1 for the last observation.

Figure 8: Difference between the German impulse responses when the reactions of loans are activated and when they are deactivated



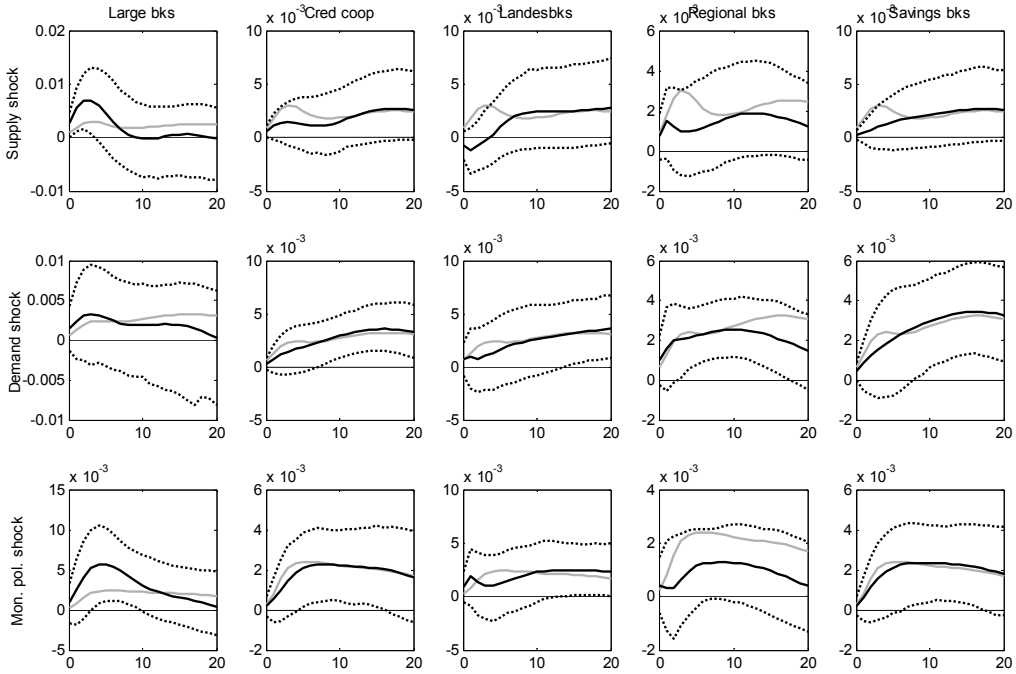
Note: "True" minus counterfactual impulse responses to shocks of one standard deviation in size. Mean: solid, 90% confidence bands: dotted. Output is real GDP, prices the GDP deflator, interest rates the three-month money market rate and loans are nominal private loans.

Figure 9: Difference between the euro-area impulse responses when the reactions of loans are activated and when they are deactivated



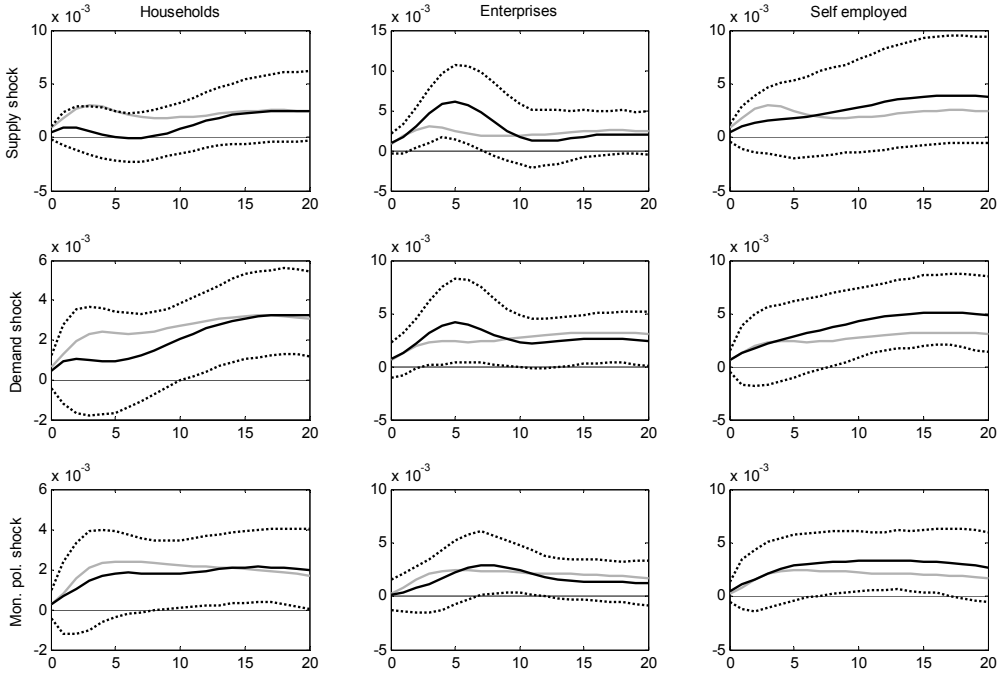
Note: "True" minus counterfactual impulse responses to shocks of one standard deviation in size. Mean: solid, 90% confidence bands: dotted. Output is real GDP, prices the GDP deflator, interest rates the three-month money market rate and loans are nominal private loans.

Figure 10: Impulse responses of loans to the private sector by banking groups, benchmark: loans by all banks to the private sector



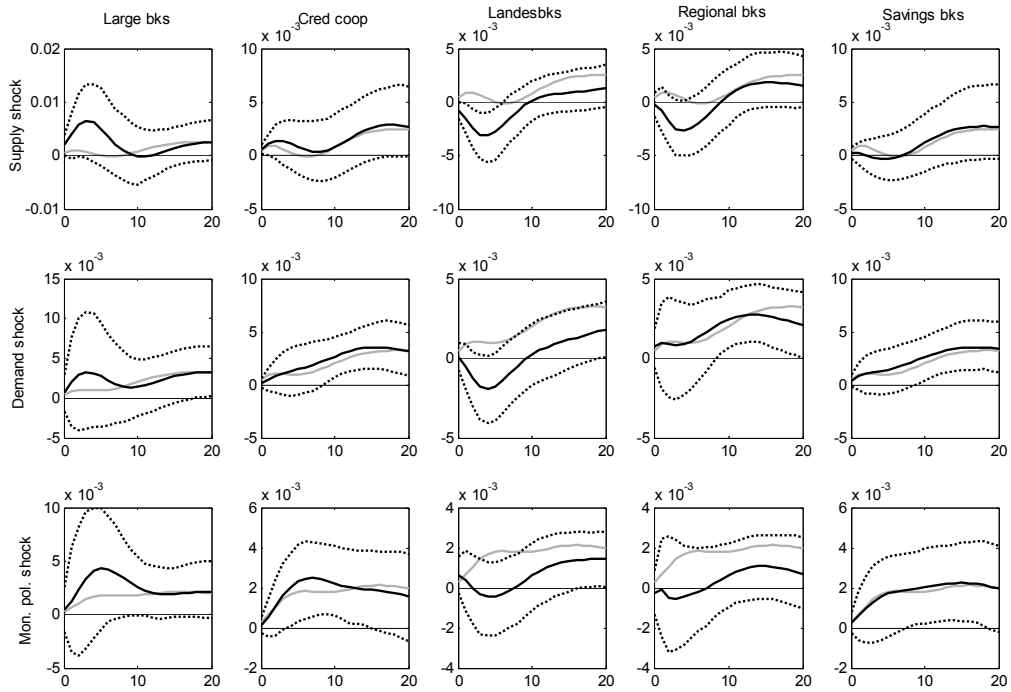
Note: Impulse responses to shocks of one standard deviation in size. Mean: solid, 90% confidence bands: dotted. The benchmark is drawn in gray.

Figure 11: Impulse responses of loans to different sectors; benchmark: loans by all banks to the private sector



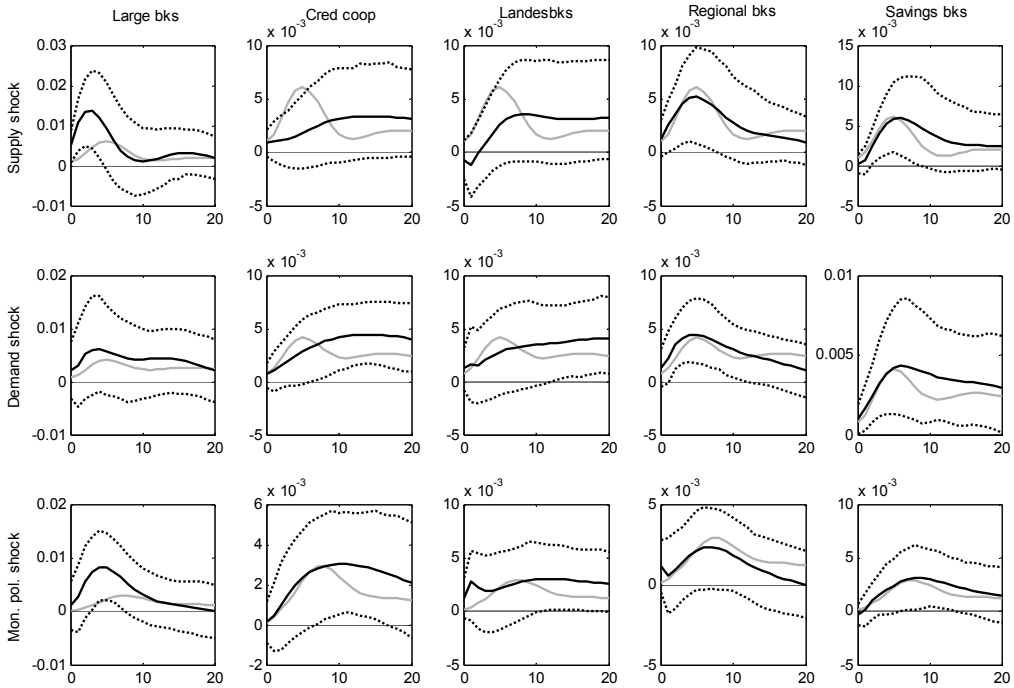
Note: Impulse responses to shocks of one standard deviation in size. Mean: solid, 90% confidence bands: dotted. The benchmark is drawn in gray.

Figure 12: Impulse responses of loans to households by banking groups, benchmark: loans by all banks to households



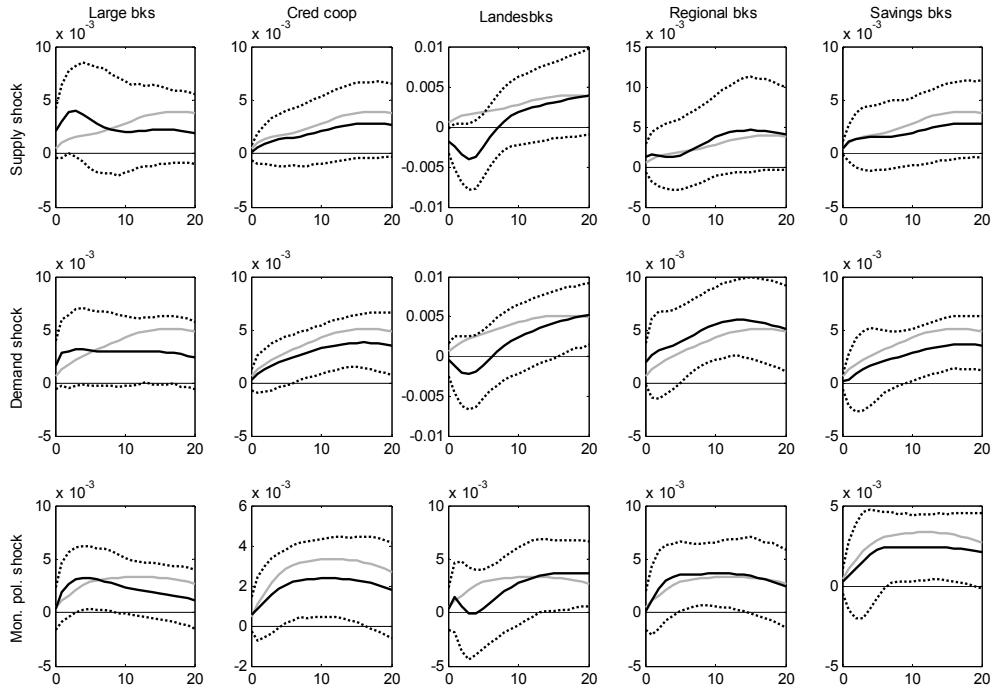
Note: Impulse responses to shocks of one standard deviation in size. Mean: solid, 90% confidence bands: dotted. The benchmark is drawn in gray.

Figure 13: Impulse responses of loans to enterprises by banking groups, benchmark: loans by all banks to enterprises



Note: Impulse responses to shocks of one standard deviation in size. Mean: solid, 90% confidence bands: dotted. The benchmark is drawn in gray.

Figure 14: Impulse responses of loans to self-employed persons by banking groups, benchmark: loans by all banks to the self-employed



Note: Impulse responses to shocks of one standard deviation in size. Mean: solid, 90% confidence bands: dotted. The benchmark is drawn in gray.

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