Monetary policy and bank lending
Evidence from German banking groups

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Abstract
This paper analyses the impact of monetary shocks on bank lending in Germany. We follow a cross-sectoral approach by looking at six different banking groups. In general, smaller banks hold a larger buffer of liquid assets which they can use to offset monetary shocks. In addition, the response of bank lending after a monetary contraction is very different across banking sectors. Lending by the credit cooperatives, which are on average the smallest banks, declines most, whereas big banks are able to shield their loans portfolio against monetary shocks. Overall, our results provide support for the existence of a bank lending channel.

Keywords: Monetary policy, bank lending
JEL codes: E50, E51, G21

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1. INTRODUCTION

The purpose of this paper is to provide empirical evidence on the role of banks in the monetary transmission process. The implications of the German institutional setting for the impact of monetary policy on bank lending are a priori ambiguous. On the one hand, the mere fact that banks play an important role suggests that the scope for an effective bank lending channel is potentially large. On the other hand, banks may try to shield their loans portfolio from monetary disturbances which may weaken, rather than strengthen, the impact of monetary policy. The latter may be particularly relevant for Germany, given the importance of long-run relationships between banks and clients in this country.

In this paper, we look whether evidence can be found for a ‘bank lending channel’ of monetary policy, by considering the response of bank lending to monetary shocks. It is well-known that this kind of research is complicated by a serious identification problem: is the fall in bank lending after a monetary tightening induced by supply or by demand? Several recent studies based on US data have addressed this problem by analysing disaggregated data, either for borrowers (e.g. Gertler and Gilchrist, 1993a, 1994; Gilchrist and Zakrajšek, 1998) or for lenders (e.g. Kashyap and Stein, 1995, 1999). We follow the latter approach, by considering different banking groups, as defined in the Bundesbank’s Banking Statistics. In this way, we capture one key element of the bank lending channel, namely that some types of banks (particularly the smaller ones) face more information problems and find it more difficult to neutralize monetary shocks than other types of banks (typically large ones).

Is it still sensible to look at Germany separately after the start of EMU? After all, monetary policy is first and foremost based on euro-wide aggregated data now. However, credit markets are still likely to exhibit specific national characteristics (see e.g. De Bondt, 2000). Hence, as
cross-national differences in monetary transmission may complicate the implementation of a common monetary policy, it is still useful to consider individual EMU economies.

The organization of this paper is as follows. The next section discusses recent literature on monetary transmission and bank lending. Section 3 gives an overview of the German banking system and discusses key characteristics of banking groups. In Section 4, we present our empirical results. We look at cross-sectoral differences in balance sheet structure and present dynamic simulations of the response of bank lending to monetary shocks. Section 5 concludes.

2. THE BANK LENDING CHANNEL

In recent years, a vast literature has developed on the effectiveness of monetary policy and the channels through which this policy works. This renewed interest in monetary transmission must be seen within the context of a revival of theories that stress the impact of the financial system on aggregate economic activity. This literature, known as the ‘credit view’, takes as a point of departure the assumption that financial markets are characterized by imperfections and that bank assets (loans, securities) are imperfect substitutes (see Bernanke and Gertler, 1995; Kakes, 2000). One of the implications is that monetary policy may affect the economy through a ‘bank lending channel’. According to this mechanism, banks respond to a monetary contraction by reducing the supply of loans which, eventually, affects inflation and real activity.

The existence of a lending channel implies that the Modigliani-Miller propositions do not hold for both borrowers and banks. Obviously, a lending channel becomes irrelevant if
borrowers can easily switch to substitutes for bank loans (e.g. commercial paper). In a similar way, banks may shield their loans portfolio by using their other assets (e.g. bonds) as a liquidity buffer against monetary shocks, or offset the outflow of deposits by attracting non-deposit funding. In Appendix A, we present a stylized model that illustrates how bank balance sheet structure is related to the working of a lending channel.

In the empirical literature, the relevance of the bank lending channel has been a controversial issue, due to a fundamental identification problem (Bernanke and Gertler, 1995; see also Kashyap et al., 1993, 1996, and Oliner and Rudebusch, 1996, for a discussion). Namely, in contrast with the lending channel, a fall in aggregate lending after a monetary contraction may be driven by demand, rather than supply. In that case, other transmission channels (e.g. changes in interest rates or the exchange rate) may cause an economic downturn and bank lending follows passively. Studies that analyse the response of aggregate credit to monetary shocks, in the spirit of Bernanke and Blinder (1992), are therefore inconclusive as regards the existence of a bank lending channel.

In order to address the identification problem, several recent studies have considered disaggregated data. The advantage of disaggregated data is that the response of bank lending can be analysed in combination with other hypotheses that follow from the underlying theoretical literature. Information asymmetries, for instance, are presumably more relevant for particular categories of borrowers. In general, firm size is considered a natural proxy for information asymmetry. Gertler and Gilchrist (1993a, 1994) and Gilchrist and Zakrajšek (1998) use quarterly panel data of nonfinancial firms in the United States and conclude that, following a monetary contraction, bank credit to small firms is reduced more than bank credit to large firms. Kashyap and Stein (1995, 1999) analyse disaggregated data of banks and find
that large banks are better able to neutralize monetary shocks than small banks. Just like small nonfinancial firms, small banks face more credit market imperfections and have only limited access to alternative sources of finance, so they cannot absorb monetary shocks as easy as larger banks. Kashyap and Stein (1999) also find that, within the category of small banks, lending is reduced most by institutions with less liquid balance sheets.

2.1 Previous work with Germany data

Empirical studies have come to different conclusions about the importance of a bank lending channel in Germany. On the basis of a number of qualitative indicators, Kashyap and Stein (1997) conclude that a bank lending channel is more likely to be relevant for Germany than for most other European countries. Ehrmann (2000) provides further support based on disaggregated data: monetary policy has more of an impact on small firms than on large firms. However, VAR studies by Barran et al. (1997), Guender and Moersch (1997), Küppers (2000) and Kakes et al. (2001) suggest that a bank lending channel is not important. See also Worms (1998) for an overview of issues related to bank lending and monetary transmission in Germany.

Favero et al. (1999) and De Bondt (2000) perform cross-section analyses with disaggregated bank balance sheet data. Favero et al. (1999) focus on the year 1992, when monetary policy was tightened by the Bundesbank. They conclude that large banks shield their loans portfolio, while small banks even expand their lending, which is in contrast with the lending channel. However, De Bondt (2000) finds support for a bank lending channel: larger and/or more liquid banks are better able to absorb monetary shocks. These diverging conclusions might be due to the fact that both studies consider a different subsample of German banks and look at
different periods.\footnote{In Section 4 we present similar ‘perverse’ results for so-called ‘private banks’ – a subcategory of relatively small institutions – as Favero et al. (1999) find for small banks in general, which might suggest that private} A drawback of these cross-sections is that they focus on a short period. Unfortunately, detailed time series at the individual bank level are not publicly available for Germany over a sufficiently long period.

2.2 Our approach

By looking at time series for different banking groups over a relatively long sample, we present a useful alternative to the studies of Favero et al. (1999) and De Bondt (2000). The Bundesbank publishes balance sheet data for each banking group on a quarterly – in some cases even monthly – basis, which enables us to perform dynamic simulations in the spirit of Kashyap and Stein (1995). Hence, the value-added of our approach is that adjustment processes can be better modelled while it is unlikely that possible idiosyncracies of a particular period drive the results. However, as we do not have data at the individual bank level, we cannot test whether banks within each class respond differently, as Favero et al. (1999) and De Bondt (2000) do. Our approach should be seen as complementary to these studies: our analysis is more general because we consider a larger sample period and look at a more representative picture of the banking sector. At the same time, our approach is less rigorous because we consider groups of banks rather than individual bank level data.

Our central hypothesis is that it is more difficult to neutralize monetary shocks for small banks than for large banks. Hence, one would expect that smaller banks (i) need to hold more liquid assets as a buffer against monetary shocks and (ii) need to reduce their lending activity more sharply after a monetary contraction. Large banks, by contrast, are supposed to have better access to nondeposit funding, which enables them to neutralize an unanticipated withdrawal of deposits more easily. These two predictions follow from the underlying theory...
of the bank lending channel and have been established empirically by Kashyap and Stein (1995, 1999) for banks in the United States. Note that (i) and (ii) are to some extent interdependent, as a larger liquidity buffer enables a small bank to shield its loans portfolio.² Hence, one would expect that if a small bank’s lending does not respond significantly to a monetary contraction, this should be reflected in a substantial reduction in its securities holdings. Large banks, on the other hand, should be able to insulate their loans portfolio from monetary shocks without having to sell their liquid assets.

It should be taken into account that we only focus on the ‘first stage’ of the bank lending channel. Obviously, if banks respond to monetary shocks in the way predicted, it is still possible that borrowers who face a fall in loans supply can switch to alternative sources of finance. Hence, our analysis should also be seen as complementary to other studies like Ehrmann (2000), who focuses on differences in the responses of real activity across classes of nonfinancial firms in Germany.

3. THE ORGANIZATION OF THE GERMAN BANKING SYSTEM

One of the key features of the German banking system is its fragmented structure. Different types of banks have co-existed for a long time. The Bundesbank’s monthly Banking Statistics reports figures of each of these ‘banking groups’, which makes it possible to follow their deposits and lending activities through time. Figure 1 gives an overview of the structure of the German banking system (the number of banks within each group is presented in parentheses). A first distinction is between universal banks and specialized institutions. The latter consist of mortgage banks and banks with special functions (e.g. export finance, start-up finance for

banks are overrepresented in their sample.
German enterprises. As the specific characteristics of these institutions complicates a direct comparison with other banks’ behaviour, we focus on universal banks, which represent the bulk (about 75%) of banking activity in Germany. As the name suggests, universal banks offer a broad range of activities.

The universal bank sector comprises three main categories, which can be further divided into banking groups (see Edwards and Fischer, 1994, for a more extensive discussion):

1. **The commercial bank sector.** The first group within this sector comprises the so-called *big banks*, which currently consist of four banks (Deutsche Bank, Commerzbank, Dresdner Bank, Hypo-Vereinsbank). The second category consists of the *regional banks*, which usually concentrate on particular regions, although some are active on a national basis. These banks are on average much smaller than the big banks, but some of them are among the ten largest banks in Germany.³ The third group comprises the *private banks*. These are typically very small and are often specialized in particular activities such as export finance or securities trading. As a group, however, they are engaged in a broad range of ‘investment bank’ activities. Finally, there is a category of *branches of foreign banks*, but this group is (as yet) hardly significant within the German banking system.

2. **The savings bank sector.** This sector consists of two groups, which act as a two-tier system. First, there are a large number of local *savings banks* which are usually allowed to be active only in their own region. The second group consists of the *Landesbanks* (also known as ‘state savings banks’ or ‘central giro institutions’). These banks are among the

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² By using data at the individual bank level, Kashyap and Stein (1999), Favero et al. (1999) and De Bondt (2000) are able to consider these two effects separately.
³ Example are the Bayerische Vereinsbank and the Hypo Bank (see Edwards and Fischer, 1994). Since 1999 (not in our sample), these two banks have merged into Hypo-Vereinsbank and are classified as big banks.
largest in Germany and function as clearing houses for the local savings banks in their region. Both categories are owned by their local governments and traditionally have a public function, such as providing services to the public authorities and financing local investment. Over time, however, they have become more and more involved in commercial activities (see Sinn, 1999).

3. **The credit cooperative sector.** Like the savings bank sector, this is a two-tier system. First, there are a large number of small credit cooperatives with a local function. Second, there are regional cooperative institutions, which provide clearing services to these credit cooperatives and are engaged in other activities such as securities trading and (international) investment banking. Credit cooperatives are owned by their members (local individuals, firms); cooperative institutions are usually owned by their local credit cooperatives.

The market shares of banking groups, in terms of business volume, have been rather stable during the past three decades (see Table 1). The savings banks sector is by far the most important: the local savings banks and the Landesbanks together account for almost half of aggregated banking activity. Hence, the share of government-owned banks is remarkably large, compared to other European countries and the United States (Sinn, 1999). Big banks, regional banks and credit cooperatives also have a significant market share, whereas the role of cooperative institutions and private banks is very modest at the aggregate level.

<Insert Table 1 about here>

A crucial difference across banking groups, which we exploit in this paper, concerns the average size of individual banks in each category. This is shown in Table 2, in terms of
business volume, as a percentage of the average size of big banks.\textsuperscript{4} Banking groups are presented in the order of their size. Besides big banks themselves, Landesbanks and cooperative institutions clearly show up as large organizations. At the other end of the spectrum are the credit cooperatives, while the savings banks and private banks can also be classified as small. Regional banks are somewhat problematic to interpret as a homogeneous category because, as we already indicated, this group includes some very big institutions and several smaller ones. Hence, we do not include this category in our empirical analysis in the next section.

<Insert Table 2 about here>

4  EMPIRICAL RESULTS

In this section, we discuss some of the main differences between banking groups’ lending behaviour in relation with monetary shocks. First of all, we present key statistics to illustrate cross-sectoral differences in balance sheet structure. Second, we perform impulse response simulations in order to analyse the dynamic impact of monetary shocks on balance sheet variables. We use bank balance sheet data that are published by the Bundesbank in its Banking Statistics and Monthly Report. We will mainly focus on domestic lending to the private sector, deposits and securities holdings. More detailed information about the data is given in Appendix B.

\textsuperscript{4} In 1990, immediately after German unification, the number of ‘big banks’ increased from 6 to 10, whereas the average size of these additional banks was relatively modest. Hence, the relative size of other banks in terms of the average size of big banks increased substantially in that year. In subsequent years the reverse took place due to consolidation within the group of big banks, causing the relative size of other banks to fall.
4.1 Balance sheet structure

One of the key predictions is that small banks need a larger liquidity buffer than big banks, as they are supposed to have less access to nondeposit funding. From Table 3, it can be concluded that this is indeed the case. The table shows how the liquidity of bank balance sheets has evolved over time, where liquidity is measured as the proportion of total assets that consists of cash, central bank reserves, securities and short-term interbank lending. Private banks, savings banks and credit cooperatives have a more liquid balance sheet than big banks and the Landesbanks, which is in line with what we expected. In particular, the similarity between the liquidity structure of savings banks and credit cooperatives is striking. The only banking group that is hard to interpret are the cooperative institutions, which have the most liquid balance sheets, while their average size is substantial. In general, however, we can conclude that there is a negative correlation between average bank size and liquidity, which corresponds to our hypothesis and to the situation in the United States (Kashyap and Stein, 1995, 1999).

<Insert Table 3 about here>

Table 4 shows that cross-sectoral differences in the average maturity of loans portfolios are substantial. This may be important, as we will see in the next subsection, because the response of short-term lending to a monetary shock is likely to be very different from the response of long-term lending. In general, the proportion of short-term lending has decreased over time. Short-term lending is particularly important for private banks, for which it includes more than half of the loans portfolio, whereas it is relatively unimportant for Landesbanks and savings banks.
4.2 Impulse-response simulations

In order to investigate dynamic responses of balance sheet variables to monetary policy shocks, we perform impulse-response analysis for each banking group. We estimate vector autoregressions, including the following variables:

1. **Balance sheet variables:** a broad measure of deposits (similar to M3), lending to the domestic private sector and total securities holdings.

2. **Macroeconomic variables:** the short-term interest rate, the long-term interest rate, real GDP and the GDP deflator.

3. **Exogenous variables:** we use four seasonal dummies and dummies to account for German unification and other breaks in the data (see Appendix B). In addition, we include the oil price as an exogenous variable, to take into account the effect of the oil crises.

All endogenous variables, except interest rates, are in logs and in real terms, using the GDP deflator.\(^5\) As all variables we analyse are I(1) and cointegration can be established for all specifications, the appropriate model is a vector error-correction model (VECM). We estimate the VECMs with quarterly data over a sample that runs from 1975:1 up to and including 1997:4. Apart from German unification, this is a homogeneous period in which the Bundesbank was to a large extent autonomous in its monetary policy formulation and followed a strategy of money targeting.

First, we carried out likelihood ratio tests on a VAR in levels to determine the number of lags. Subsequently, we employed the Johansen procedure to establish the cointegration rank, using

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\(^5\) We also carried out the analysis with bank balance sheet variables in nominal terms; the results are virtually the same.
the software package Microfit. Our specification of the cointegration space allows for
intercepts in the cointegration relationships and deterministic trends in the levels of the
variables. Results are reported in Table 5. The number of lags varies between 4 and 6, and the
cointegration rank is 5 or 6 for all specifications. The residuals are normally distributed in all
cases except for the private banks model. If we include one more lag, however, the test
statistic becomes 105.3 (p-value 0.067), so normality can be accepted, whereas the simulation
outcomes remain virtually the same.

Impulse-response simulations are calculated with the MALCOLM package developed by
interpreted as unanticipated monetary policy shocks. These shocks are identified by imposing
a Wold causal chain in which the policy variable is ordered first.⁶

<Insert Table 5 about here>

Figure 2 presents the responses of the balance sheet variables to a monetary contraction,
simulated as a shock to the short-term interest rate of about 40 basis points (one standard
error). The simulation period is three years (twelve quarters); the solid lines are the responses,
dotted lines represent 95% confidence intervals, calculated from the asymptotic distribution of
the moving average parameters (see Vlaar, 1998).

There are significant differences across banking groups. As expected, big banks’ assets are
not very sensitive to a monetary policy shock, despite an immediate fall in deposits. Lending
initially even increases somewhat and remains unaffected during the subsequent quarters.

⁶ Our results are robust to alternative orderings. In a previous version of this paper, we performed generalized
impulse responses with a VAR in levels (see Pesaran and Shin, 1998), which gave very similar outcomes.
Furthermore, securities holdings do not respond significantly at all, which implies that big banks do not need a buffer of liquid assets in order to absorb monetary shocks. This is consistent with our observation in Table 3 that big banks hold relatively little liquid assets. At the other end of the spectrum, the response of credit cooperatives is also in line with the central hypothesis. These banks react by reducing their loans portfolio and also appear to use their securities holdings as a buffer. The relatively fast response of lending activity suggests that this is induced by supply, as demand effects are likely to coincide with a fall in GDP which becomes significant after about a year.

The interpretation of the other four banking groups’ responses is somewhat more subtle. Just like the case of the big banks, lending initially shows a positive reaction for all groups. For Landesbanks, lending declines in the longer run. However, for the private banks and, to some extent, for cooperative institutes, the perverse positive response of bank lending persists for some time and is not followed by a decline. These responses of lending can largely be explained by short-term loans, which are likely to increase immediately after a monetary contraction. Table 4 shows that for private banks and cooperative institutes, a relatively large proportion of the loans portfolio consists of short-term lending. Furthermore, private banks’ deposits also increase after a monetary tightening, which enables them to expand their lending. Finally, it is interesting to see that all four banking groups reduce their securities holdings immediately after the monetary shock, implying that these are used as a liquidity buffer.

4.3 Possible caveats

Several studies have established that short-term lending initially increases after a monetary contraction (see e.g. Gertler and Gilchrist, 1993b). This may be due buffer stock behaviour, as firms demand more short-term loans to compensate for declining cash flows or shorten the maturity of their debts as a reaction to increases – and anticipation to future decreases – in the lending rate.
Our analysis is subject to four potential caveats. First of all, our distinction into banking groups does not exactly match the division into size categories that Kashyap and Stein (1995, 1999) have made for the United States and Favero et al. (1999) and De Bondt (2000) for Germany. We take the groups as these are defined by the Bundesbank. Nonetheless, our results show that important cross-sectoral characteristics are similar, which suggests that our disaggregation is to some extent comparable to that of the other studies. Second, we do not take interbank relationships and ownership structures into account. For instance, big banks have a large stake in mortgage banks which we do not analyse in this paper as these are specialized institutions, and cooperative institutions are partly owned by credit cooperatives. Furthermore, it is not clear to what extent the two-tier structure of the savings banks sector and the cooperative sector has an impact on the responses of the banking groups in these sectors. Third, several differences between banking groups are due to institutional factors, such as the restriction on local savings banks to be active only in their own region. Fourth, banking groups may have different types of borrowers. Large banks may have larger clients, whose credit demand is likely to be less susceptible to cyclical influences, while small banks usually have relatively more small firms and households as clients. However, we believe that the impact of borrower heterogeneity should not be overstated. According to the Bundesbank (1996), big banks’ lending is largely concentrated in the manufacturing sector. This sector is relatively sensitive to cyclical effects, which to some extent compensates the effect of larger borrowers. Furthermore, insofar as borrower heterogeneity does explain the differences across banking groups, this is fully consistent with the existence of a bank lending channel.

4.4 Evaluation

For most of the banking groups, cross-sectoral differences are consistent with the two basic predictions that smaller banks (i) hold a larger buffer stock of liquid assets and/or (ii) find it
more difficult to insulate their lending activity from monetary shocks than large banks. Those categories where average bank size is relatively small have more liquid balance sheets. Impulse-response analysis shows that only the big banks are able to shield their loans portfolio without having to reduce their securities holdings. The credit cooperatives, which are on average the smallest banks, react to a monetary contraction by reducing both their lending activity and their securities holdings. Landesbanks and savings banks take an intermediate position, as they are able to protect their loans portfolio in the short run, but also need to use their securities holdings as a liquidity buffer.

The behaviour of two banking groups, the private banks and the cooperative institutes, is difficult to interpret. Both respond to a monetary policy contraction by significantly extending their lending activity. As we already indicated, this can be partly explained by the maturity structure of their loans portfolio. In particular for private banks, the bulk of lending consists of short-term loans. In addition, these banks focus on ‘investment bank’ activities. Interestingly, the results for private banks – an extension of bank lending after a monetary contraction, financed by an increase in deposits – are very similar to the conclusions of Favero et al. (1999) for small German banks in general, which might suggest that private banks are overrepresented in their sample.8 Favero et al. explain the expansion of loans by the higher intermediation margins due to increased interest rates. Notwithstanding the fact that the behaviour of private banks and cooperative institutions are inconsistent with an explanation along the lines of the credit view, it should be noted that their market shares are very limited compared to the other banking groups (see Table 1). Hence, their impact on the aggregate picture should not be exaggerated.

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8 This also appears from their discussion of the example of Bankhaus Carl F. Plump & Co., which is a private bank, suggesting that this is a typical small bank in Germany.
5 CONCLUDING REMARKS

In this paper, we have analysed the response of bank lending to monetary shocks, focusing on differences between German banking groups. We discussed the main features of these groups, presented the most important differences in balance sheet structure, and carried out impulse-response simulations to show the main differences in lending behaviour. We focused on two key predictions: (i) for small banks it is more important to invest in a buffer of liquid assets than for large banks, and (ii) small banks find it more difficult to shield their loans portfolio after a monetary contraction than large banks. If these hypotheses can be established empirically, this would support the existence of a ‘bank lending channel’.

Especially for the largest and the smallest banks, our results are consistent with both predictions. Big banks have relatively little liquid assets and are nevertheless able to insulate their lending activity from monetary disturbances, whereas the credit cooperatives have a relatively large amount of liquid assets but still have to reduce their loans portfolio after a monetary contraction. The outcomes for two banking groups, private banks and cooperative institutions, are hard to interpret along the lines of the bank lending channel. However, as these two banking groups have a very small market share, they have little consequences for our overall conclusion.

Although our results offer some support for the existence of a bank lending channel, one should be cautious, as the limitations of our approach do not allow strong conclusions. We only focused on the ‘first stage’ of this transmission channel, i.e. the impact of monetary policy on bank lending. In addition, we analysed banks at a sectoral level, whereas a further disaggregation would make it possible to perform more precise tests of bank behaviour. It
would be useful to carry out a similar analysis with bank level data, as Kashyap and Stein (1999) have done for the United States, in order to obtain more rigorous conclusions.
APPENDIX A  A STYLIZED MODEL

The functioning of a bank lending channel, from a bank’s perspective, can be illustrated within a simple two-period framework, based on Kashyap and Stein (1995). Stein (1998) provides a more rigorous microfoundation of a similar type of model and suggests several extensions in order to arrive at a complete macroeconomic model that specifies the entire monetary transmission process. Developing such a model is beyond the scope of this appendix: our only purpose is to illustrate how a bank’s balance sheet structure affects its lending behaviour and to capture the idea that banks may invest in a buffer stock of marketable securities which enables them to offset monetary shocks.

Consider a simplified bank balance sheet:

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
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<tbody>
<tr>
<td>$L$</td>
<td>$M$</td>
</tr>
<tr>
<td>$B$</td>
<td>$N$</td>
</tr>
</tbody>
</table>

In the first period, the bank has to specify an investment portfolio of two types of assets: loans $L$ and securities (‘bonds’) $B$. Loans are an attractive investment because they yield a higher return than bonds, equal to $r$ over both periods taken together, which is exogenous to the bank. The return on bonds is normalized to zero, so $r$ can be interpreted as the spread between the return on lending and investing in bonds. A disadvantage of loans, however, is that they cannot be costlessly liquidated in period 2. We simply assume that liquidation costs are infinite or, alternatively, that loans cannot be liquidated. By contrast, bonds can be liquidated without any costs, which makes them suited to serve as a buffer stock.

In order to finance its assets, the bank can use two types of liabilities. First, the public holds demand deposits $M$ with the bank, which are fixed at $M_1$ in period 1 and $M_2$ in period 2. In the first period, the bank faces uncertainty with respect to the amount of deposits in period 2:
given $M_1, M_2$ is uniformly distributed on the interval $[\rho M_1 + (1 - \rho) \bar{M} - \gamma, \rho M_1 + (1 - \rho) \bar{M} + \gamma]$ with a mean of $\rho M_1 + (1 - \rho) \bar{M}$, where $\bar{M}$ can be interpreted as reflecting the equilibrium value of monetary stance.\(^9\) Hence, $\rho$ can be seen as a measure of persistence of a monetary disturbance in period 1, and $\gamma$ as a measure of its standard deviation. As an alternative to demand deposits, a bank can raise non-deposit external financing $N$ in both periods: these are $N_1$ in period 1 and $N_1 + N_2$ in period 2. Non-deposit finance is characterized by increasing marginal costs, which we assume to be equal to $\alpha_1 N_1^2$ and $\alpha_2 N_2^2$, where $\alpha_1, \alpha_2 \geq 0$. The relevance of a convex increasing cost function, which is essential for this model, can be explained by the fact that the bank’s creditors are likely to demand a higher return when external finance increases, since they become exposed to higher risk. This does not hold for demand deposits, which are protected by deposit insurance. The bank balance sheets in period 1 and 2, respectively, look as follows:

Period 1

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>$L$</td>
<td>$M_1$</td>
</tr>
<tr>
<td>$B_1$</td>
<td>$N_1$</td>
</tr>
</tbody>
</table>

Period 2

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>$L$</td>
<td>$M_2$</td>
</tr>
<tr>
<td>$B_2$</td>
<td>$N_1 + N_2$</td>
</tr>
</tbody>
</table>

Given these assumptions, it is easy to understand why banks are likely to invest in a buffer stock of liquid assets $B$ in the first period. In order to see this, consider the situation in period 2. There are two possibilities. First, if $M_1 + M_2 > L$, the loan portfolio can be financed without

\(^9\) This implies that monetary policy is measured by the volume of deposits, which is clearly an oversimplification compared to actual policy practice. Nevertheless, we believe that the main characteristics of the model remain useful in a more realistic setting. Shocks to the short-term interest rate, which we use as the policy variable in our empirical analysis, have an impact on deposits, which is likely to affect bank behaviour in the way described here.
any new external finance: \( N_2 \) will be zero in this case since it is always cheaper to reduce
bond holdings, which we assumed to be costless. Alternatively, if \( N_1 + M_2 < L \), the bank needs
to attract new external finance: \( N_2 = L - N_1 - M_2 \). When the bank takes its portfolio decisions
in period 1, it has to take into account that \( M_2 \) may become \( \rho M_1 + (1-\rho)M^* - \gamma \), and that it
cannot run the risk of loans having to be liquidated. Hence, if the bank finds itself in a
situation where it needs to raise non-deposit finance, i.e. \( N_2 > 0 \), the expected costs of this
external funding, formulated in period 1, are:

\[
E[\alpha_2 N_2^2] = \frac{1}{3} (L - N_1 - \rho M_1 - (1 - \rho)M^* + \gamma)^2
\]

The bank’s portfolio choice of \( L \) and \( N_1 \) in the first period, and hence \( B \), can be derived from
the following maximization problem:

\[
\begin{align*}
\max_{\alpha_1,L} & \left[ rL - \alpha_1 N_1^2 - \frac{1}{3} \alpha_2 (L - N_1 - \rho M_1 - (1 - \rho)M^* + \gamma)^2 \right] \\
\end{align*}
\]

which yields the following solution:

\[
N_1 = \frac{1}{2\alpha_1} r
\]

\[
L = \left( \frac{1}{2\alpha_1} + \frac{3}{2\alpha_2} \right) r + \rho M_1 + (1 - \rho)M^* - \gamma
\]

\[
B_1 = M_1 + N_1 - L = -\frac{3}{2\alpha_2} r + (1 - \rho)(M_1 - M^*) + \gamma
\]

These three outcomes can be given an intuitive interpretation. According to Equation (3), the
bank will raise non-deposit finance in the first period up to the point where the marginal costs
of this funding are equal to the marginal return of lending: \( 2\alpha_1 N_1 = r \). Second, Equation (4)
shows that the supply of bank loans is a positive function of its return \( r \) and the amount of
deposits in the first period, and a negative function of the variability of the money stock in the
second period, indicated by \( \gamma \). Finally, Equation (5) implies that banks will hold a large buffer
stock of bonds $B$ if there is a lot of uncertainty $\gamma$ with respect to monetary stance – i.e. if the maximum possible fall in deposits is large – while $B$ further depends negatively on the return $r$ on loans and the degree of persistence $\rho$ of monetary disturbances.

The parameters $\alpha_1$ and $\alpha_2$ indicate the cost of non-deposit funding for a bank. These parameters are likely to be higher for small banks than for large banks, which implies on the basis of (5) that smaller banks hold a larger buffer stock of securities $B$. If $\alpha_1$ and $\alpha_2$ would be zero, this implies that external funding is costless: in such a case, a bank would always be able to offset any unanticipated deposit withdrawal, which makes a bank lending channel impotent. Differentiation of (4) with respect to $M_1$ yields:

\[
\frac{dL}{dM_1} = \rho + \left( \frac{1}{2\alpha_1} + \frac{3}{2\alpha_2} \right) \frac{dr}{dM_1}
\]

Under general conditions, $\frac{dr}{dM_1} < 0$ which implies that the impact of changes in monetary conditions $M_1$ affects lending more as $\alpha_1$ and $\alpha_2$ are higher. Hence, the prediction is that, if a lending channel is relevant, lending by small banks will respond stronger to monetary shocks than lending by large banks.
Balance sheet data are published in the Bundesbank’s *Monthly Report* and *Banking Statistics*. Most of these series are taken from the CD-ROM *50 Jahre Deutsche Bundesbank* or from Datastream. Other variables are taken from the IFS. More detailed information:

- **Bank balance sheet data.** The data in Tables 1, 2 and 3 apply to total bank activity, including interbank lending. In Table 4 and for the estimation of VECMs we used data on lending and deposits vis-à-vis the nonbank private sector. Our definition of deposits is virtually equal to M3.

- **Macroeconomic variables.** Nominal and real GDP are taken from the IFS database. From 1990 onwards, these data include the new states of the former GDR. The short-term interest rate is the three-month interbank rate, and the long-term interest rate is the government bond yield, both taken from the IFS.

- **Exogenous variables.** We use seasonal dummies and dummies to correct for breaks. For German unification we include a dummy which is equal to one from 1990:2 onwards. Further, we include specific dummies for each banking groups to correct breaks in the bank balance sheet data (due to definition changes etc.). Finally, we include the oil price in the VECM.
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<table>
<thead>
<tr>
<th>TABLE 1</th>
<th>Market share of banking groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Big banks</td>
<td>12.8</td>
</tr>
<tr>
<td>Regional banks</td>
<td>13.5</td>
</tr>
<tr>
<td>Private banks</td>
<td>2.5</td>
</tr>
<tr>
<td>Landesbanks</td>
<td>21.8</td>
</tr>
<tr>
<td>Savings banks</td>
<td>28.7</td>
</tr>
<tr>
<td>Regional institutions</td>
<td>5.7</td>
</tr>
<tr>
<td>Credit cooperatives</td>
<td>12.1</td>
</tr>
<tr>
<td>Other</td>
<td>3.0</td>
</tr>
</tbody>
</table>

Market share (in % of universal banks’ volume of business)
Source: Bundesbank

<table>
<thead>
<tr>
<th>TABLE 2</th>
<th>Average size of individual banks within each banking group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Big banks</td>
<td>100.0</td>
</tr>
<tr>
<td>Regional banks</td>
<td>5.6</td>
</tr>
<tr>
<td>Private banks</td>
<td>0.9</td>
</tr>
<tr>
<td>Landesbanks</td>
<td>85.4</td>
</tr>
<tr>
<td>Savings banks</td>
<td>2.0</td>
</tr>
<tr>
<td>Regional institutions</td>
<td>22.1</td>
</tr>
<tr>
<td>Credit cooperatives</td>
<td>0.2</td>
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</tbody>
</table>

Relative size (volume of business) in terms of average big banks
Source: Bundesbank

<table>
<thead>
<tr>
<th>TABLE 3</th>
<th>Balance sheet liquidity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Big banks</td>
<td>0.21</td>
</tr>
<tr>
<td>Private banks</td>
<td>0.37</td>
</tr>
<tr>
<td>Landesbanks</td>
<td>0.21</td>
</tr>
<tr>
<td>Savings banks</td>
<td>0.31</td>
</tr>
<tr>
<td>Regional institutions</td>
<td>0.37</td>
</tr>
<tr>
<td>Credit cooperatives</td>
<td>0.32</td>
</tr>
</tbody>
</table>

Liquid assets (cash + central bank reserves + securities + short-term interbank lending) as a fraction of total assets
Source: Bundesbank
### TABLE 4  Proportion of short-term lending to firms and households

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Big banks</td>
<td>0.48</td>
<td>0.40</td>
<td>0.43</td>
<td>0.37</td>
<td>0.40</td>
<td>0.34</td>
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<tr>
<td>Private banks</td>
<td>0.74</td>
<td>0.78</td>
<td>0.78</td>
<td>0.64</td>
<td>0.63</td>
<td>0.54</td>
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<tr>
<td>Landesbanks</td>
<td>0.19</td>
<td>0.14</td>
<td>0.14</td>
<td>0.12</td>
<td>0.16</td>
<td>0.13</td>
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<tr>
<td>Savings banks</td>
<td>0.37</td>
<td>0.23</td>
<td>0.20</td>
<td>0.17</td>
<td>0.18</td>
<td>0.16</td>
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<tr>
<td>Regional institutions</td>
<td>0.42</td>
<td>0.47</td>
<td>0.51</td>
<td>0.39</td>
<td>0.48</td>
<td>0.38</td>
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<tr>
<td>Credit cooperatives</td>
<td>0.41</td>
<td>0.32</td>
<td>0.27</td>
<td>0.23</td>
<td>0.23</td>
<td>0.20</td>
</tr>
</tbody>
</table>

Source: Bundesbank

### TABLE 5  VECM models

<table>
<thead>
<tr>
<th></th>
<th># Lags</th>
<th>Rank</th>
<th>Normality* (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Big banks</td>
<td>5</td>
<td>5</td>
<td>102.7 (0.093)</td>
</tr>
<tr>
<td>Landesbanks</td>
<td>5</td>
<td>5</td>
<td>92.5 (0.271)</td>
</tr>
<tr>
<td>Regional institutions</td>
<td>6</td>
<td>4</td>
<td>95.4 (0.206)</td>
</tr>
<tr>
<td>Private banks</td>
<td>5</td>
<td>6</td>
<td>192.9 (0.000)</td>
</tr>
<tr>
<td>Savings banks</td>
<td>6</td>
<td>6</td>
<td>102.2 (0.098)</td>
</tr>
<tr>
<td>Credit cooperatives</td>
<td>5</td>
<td>5</td>
<td>83.3 (0.532)</td>
</tr>
</tbody>
</table>

*Mardia multivariate normality test
FIGURE 1  Structure of the German banking system (in parentheses: number of institutions in 1995).

- **Bundesbank**
  - Universal banks
  - Specialized banks
    - **Commercial bank sector**
      - Big banks (3)
      - Regional banks (198)
      - Private banks (65)
      - Foreign br. (69)
    - **Savings bank sector**
      - Landesbanks (13)
      - Savings banks (626)
    - **Credit cooperative sector**
      - Regional inst. (4)
      - Cooperatives (2591)
FIGURE 2 Responses of bank balance sheet variables to a shock in the short-term interest rate
FIGURE 2 (continued)

Private banks

Savings banks

Credit cooperatives

Deposits

Lending

Securities

0 2 4 6 8 10 12

0 2 4 6 8 10 12

0 2 4 6 8 10 12

-0.01

0.00

0.01

0.02

-0.01

0.00

0.01

-0.01

0.00

0.01

0 2 4 6 8 10 12

0 2 4 6 8 10 12

0 2 4 6 8 10 12

-0.01

0.00

0.01

0.02

-0.01

0.00

0.01

0 2 4 6 8 10 12

0 2 4 6 8 10 12

0 2 4 6 8 10 12

-0.02

0.00

0.02

-0.01

0.00

0.01

-0.01

0.00

0.01

0 2 4 6 8 10 12

0 2 4 6 8 10 12

0 2 4 6 8 10 12

0.01

0.02