The pass-through from market interest rates to bank lending rates in Germany

Bank lending rates play a key role in the process of monetary policy transmission. An in-depth analysis was therefore made of the relationship between money market and capital market rates and the interest rates on lending by German banks in the 1990s. As a result, structural differences in the interest rate pass-through became apparent across different banks. The speed at which lending rates adjust to changes in market rates depends on bank size, the banks' specific refinancing conditions and the extent of their non-bank business. In the case of corporate lending, in particular, credit institutions only gradually adjust their terms and conditions to changes in market rates. By smoothing their lending rates, banks accept temporary fluctuations in their interest rate margin. The monetary policy transmission process therefore tends to take longer as monetary policy measures are only gradually passed on to households and non-financial firms.

Bank rates and monetary policy transmission

Interest rate channel of monetary policy transmission ...

The monetary policy measures taken by the central bank focus on the short-term interbank market. However, they also affect the rates on all financial markets and thereby influence aggregate demand and price developments. According to the interest rate channel theory, higher interest rates curb spending

by households and firms while low interest rates act as a stimulant.

... and credit channel

According to the theoretical literature, banks do not play an active role in monetary policy transmission via the interest rate channel since bank credit and borrowing in the market or bank deposits and portfolio investments are considered to be fully substitutable. Both firms and banks can change to another type of financing without incurring any additional costs. However, things are different in reality: most private enterprises cannot simply raise funds in the money or capital markets as an alternative to bank credit as the various lenders have insufficient information about the enterprises' creditworthiness. The banks are equally unable to raise resources on the same terms in the market as an alternative to their deposits. Moreover, the credit institutions do not have unlimited liquidity reserves and may only be able to partially adjust their assets following a monetary policy tightening. All these factors may result in monetary policy impulses affecting the banks' credit supply and consequently corporate investment activity. In the economics literature, reference is made in this connection to the credit channel, which operates in parallel to the interest rate channel.[1]

Role of bank interest rates

In the context of the monetary policy transmission process, an important role is assigned to bank interest rates. What is of particular interest is the speed and the extent to which German banks adjust their lending rates to interest rate movements in the money or capital markets.[2] These interest rate relationships are, of course, only one component of the monetary policy impulses that are transmitted via bank interest rates. The extent to which investment by firms and borrowing by the other non-banks depend on bank lending rates is also important. In addition, the effect of the banks' deposit rates on households' savings and investment decisions is another factor for consideration.

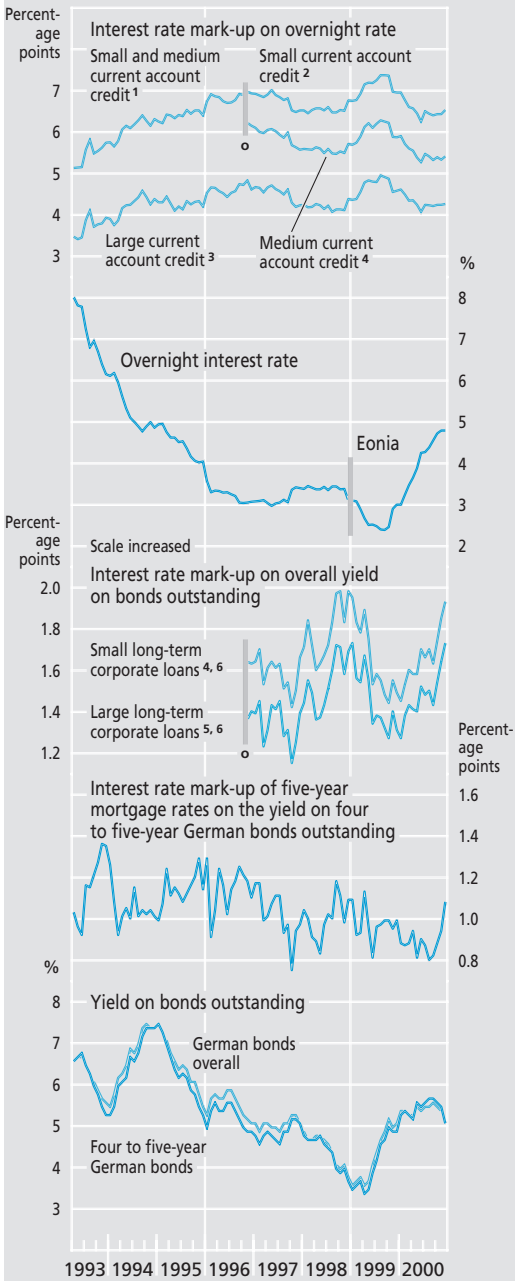
Gradual interest rate adjustment, especially for corporate loans

As a general rule, banks adjust their lending rates to changes in market rates only gradually. However, the extent to which this applies to the different types of credit varies (see the chart on page 51). An anticyclical curve of the mark-up between the average lending rate and a market rate with a similar maturity becomes apparent, especially in the case of corporate lending rates. By contrast, the corresponding interest rate mark-up for five-year mortgage rates changes little over the interest rate cycle. This observation for the average interest rates is an indication that interest rate smoothing is more important for corporate lending rates and less important for mortgage rates. Lending rate stickiness may be caused by several factors. The more uncertain banks are about the future development of general market rates, the longer they are likely to leave their lending rates unchanged. A delayed response may also be due to adjustment costs, with the result that preference is given to making less frequent, but larger interest rate changes over continuously ad-

1 See Deutsche Bundesbank, Bank balance sheets, bank competition and monetary policy transmission, *Monthly Report,* September 2001, p 51–70.
2 This issue has been addressed in a research paper; see M A Weth, *The pass-through from market interest rates to bank lending rates in Germany,* Economic Research Centre, Deutsche Bundesbank, Discussion Paper 11/02, March 2002.

justing interest rates. In addition, shifts in credit demand[3] and changes in the banks' competitive position can influence pass-through. If competition is weak, the banks may tend, for instance, to increase their interest rate margin in periods of falling interest rates by reducing their lending rates more slowly than their deposit rates. Similarly, in periods of increasing market rates, banks could try to delay a narrowing of their margin by passing rising refinancing costs promptly on to their customers in the form of higher lending rates. Accordingly, the speed at which their lending rates adjust to market rates can vary over the interest rate cycle, with the result that interest rate margins do not follow the market rate in a uniformly anticyclical manner. Rather, lending rates tend to be adjusted less markedly in periods of falling interest rates and more rapidly in times of rising interest rates.[4] On the basis of the available data, it is, however, impossible to carry out an empirical analysis of this asymmetry because the data cover too short a period of time.[5] The level of financial market development, the degree of financial market openness and the structure of banks' balance

Mark-up of lending rates on market rates



1 Credit of less than DM1 million. — **2** Credit of less than DM200,000. — **3** Credit of DM1 million and more but less than DM5 million. — **4** Credit of DM200,000 and more but less than DM1 million. — **5** Loans of DM1 million and more but less than DM10 million. — **6** Loans with interest rates locked for more than five years. — **o** Collected since November 1966.

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3 Effects produced by credit demand were, however, not analysed in this study.

4 The asymmetry of the lending rate response in the interest rate cycle has been reviewed, for example, by C E V Borio, and W Fritz, The response of short-term bank lending rates to policy rates: A cross-country perspective, in *Financial structure and the monetary policy transmission mechanism,* Bank for International Settlements, March 1995.

5 The analysis described in this article relates to the period from April 1993 to December 2000.

sheets also determine the lending rate pass-through.[6]

Continued importance of monetary policy transmission via banks

On the basis of aggregate data, it is, however, virtually impossible to test for the relevance of the different explanatory approaches. The alternative is to analyse the interest rate reports made by the individual banks. Balance sheet features can thus provide information about a bank's ability to isolate its lending rate policy from market conditions. The extent to which the adjustment behaviour of German bank lending rates in the 1990s coincides with a specific balance sheet profile has therefore been reviewed. This issue is particularly relevant from the monetary policy perspective as bank loans still play an important role in corporate financing in Germany. In 2000 outstanding loans by monetary financial institutions to enterprises amounted to just under 40% of total external corporate financing, with small enterprises displaying an above-average dependence on bank loans. From the banks' point of view, too, lending to non-banks (including enterprises) is an important part of their total business – even if its role is declining for certain categories of banks. Last year non-bank loans accounted for just under half of the banks' balance sheet total and loans to firms and self-employed persons for around one-fifth.

Interest rate response and balance sheet structure

Importance of refinancing conditions ...

Several considerations favour differences in the adjustment response across individual banks to changing conditions in the financial markets. The differences in the credit institutions' refinancing conditions are frequently stressed as a factor influencing the level of the lending rate.[7] Banks with market-oriented refinancing costs possibly depend more on adjusting their credit terms than banks whose liability structure is less influenced by interest rate changes in the market.

... and savings deposits ...

Savings deposits probably play a particular role in this respect. Although the interest rates on savings deposits have recently become more variable, savings deposits in Germany nonetheless represent an important category of deposits whose interest rates are affected comparatively little by market rate movements. They are mainly available to banks as longer-term deposits. Institutions which resort extensively to these kinds of deposits for refinancing purposes feel less pressurised to promptly adjust their lending rates than institutions whose refinancing costs increase at the same time and to a similar extent as market rates. This suggests that lending rate setting by German banks depends, among other factors, on the share of its customers' savings deposits. The more intensely a bank competes with other financial institutions or with the securities markets, the more it will need to adjust its refinancing rates to

6 See the multi-country studies by C Cottarelli and A Kourelis, *Financial structure, bank lending rates and the transmission of monetary policy,* International Monetary Fund Staff Papers, No 41, December 1994, p 587–623, and B Mojon, *Financial structure and the interest rate channel of ECB monetary policy,* European Central Bank Working Paper No 40, November 2000.

7 See C Cottarelli, G Ferri, and A Generale, *Bank Lending Rates and Financial Structure in Italy: A Case Study,* International Monetary Fund Staff Papers, No 38, September 1995, p 670–700. See also M Berlin, and L J Mester, Deposits and Relationship Lending, *The Review of Financial Studies,* Vol 12, No 3, Fall 1999, p 579–607.

the corresponding market conditions. In fact, the development of money market and investment funds since 1994 and the tendency for bank deposits to become less important indicate that bank customers are making greater use of alternative forms of investment.[8] At the same time, the dependence on bank loans decreased in the 1990s, especially for firms that were able to make use of alternative sources of financing as a result of improved access to the money market or the capital market.[9]

... but greater importance of forms of investment with market-related interest rates

Importance of the "housebank" principle

In addition to the various refinancing conditions, the prime role of the "housebank" in the German financial system may account for a certain amount of interest rate smoothing. In a "housebank relationship", the bank temporarily accepts lower margins in periods of rising interest rates so as not to jeopardise long-term customer loyalty and the associated information advantages over other capital providers. In good and in difficult times, the borrower has the advantage of being able to rely on business relations that have been built up over time. This is particularly attractive to smaller-scale borrowers who would be unable to borrow from another source on the same terms as would be available on a loan from their "housebank". The borrower "pays for" this advantage to a certain extent by a higher interest rate mark-up in periods of falling interest rates. Interest rate smoothing thus follows on from splitting risk between the bank and its customers.[10] "Housebank relationships" may also operate in terms of deposits, in which case the bank is the borrower. Similarly, it is not easy to borrow on the same terms in the market as an alternative to bank deposits. The harder it is for the bank to find alternative sources of financing, the more intensely it will cultivate close, lasting relations with its depositors.

In the study described in this article, the banks' status as "housebanks" is approximated by the share of long-term non-bank business in the balance sheet total. Long-term non-bank business was calculated as the total of loans to non-banks and non-banks' deposits with agreed maturities of more than one year. The thinking behind this is that it is in the interests of a bank with relatively extensive long-term non-bank business to maintain close relationships with its customers and it therefore lays greater store on acting as a "housebank" than one whose long-term non-bank business is only of minor importance.

Importance of bank size

Bank size is frequently taken as a further determinant of the extent to which, in terms of their lending business, banks respond to monetary policy impulses.[11] With regard to the credit channel, it is assumed that the size of a credit institution is related to its ability to call on alternative sources of refinancing and

8 See also European Central Bank, Monetary policy transmission in the euro area, *Monthly Bulletin,* July 2000, p 43–58.
9 See Deutsche Bundesbank, The relationship between bank lending and the bond market in Germany, *Monthly Report,* January 2000, p 33–47.
10 See also A N Berger, and G F Udell, Some Evidence on the Empirical Significance of Credit Rationing, *Journal of Political Economy,* 1990, Vol 100, p 1047–1077.
11 See A K Kashyap and J C Stein, What do a Million Observations on Banks Say about the Transmission of Monetary Policy?, *American Economic Review,* Vol 90 (2000), No 3, p 407–428. See also Cottarelli et al (1995), *op cit* and I Angeloni, L Buttiglione, G Ferri and E Gaiotti, *The Credit Channel of Monetary Policy across Heterogeneous Banks: The Case of Italy,* Temi di discussione, Banca d'Italia, No 256, September 1995.

thus, to a degree, to "side-step" a restrictive monetary policy. Accordingly, small banks whose deposits decrease as a result of a tightening of monetary policy can raise only limited additional finances in the market and consequently may have to restrict their lending. For Germany, however, there are indications that smaller banks are less affected by financing shortages if they belong to a banking federation and can borrow through their central institution.[12] For Germany, bank size is therefore not a reliable indicator of the availability of alternative forms of refinancing. For this reason the refinancing conditions of many small banks probably do not worsen following a restrictive monetary policy or do so only to a limited extent. Contrary to the credit channel theory, their lending rates can therefore be expected to respond less to interest rate increases in the market than those of large banks.

Nonetheless, a certain correlation between the size of a bank and that of its borrowers may well exist. It can be assumed that borrowers from small institutions are frequently small and medium-sized enterprises, which are more dependent on bank loans, whereas larger institutions lend more to larger firms, which have alternative means of raising finance in the market. As a rule, this is likely to be reflected in larger banks setting interest rates more closely in line with market conditions. Bank size would therefore be significant mainly in terms of corporate lending.

Although the possibility that the size of a bank is related to its savings deposits and its total long-term non-bank business cannot be ruled out, these three determinants of the lending rate pass-through were analysed independently of one another.

Interest rate data

For the purpose of analysing the lending rate policy of German banks, short-term and long-term loan categories were selected. For short-term lending business, the Bundesbank collects data, for instance, on current account credit rates charged on new credit line agreements or on their renewal. Current account credit frequently represents standard loans to corporate customers. Rather than a fixed rate of interest, in these loan agreements a mark-up of the money market rate is usually offered to "blue-chip" customers, with a mark-up of an internal bank prime rate applying for other borrowers. For long-term loans, interest rates on new business or renewals are taken, as relating to both five-year mortgage loans and longer-term corporate loans with an agreed interest rate lock-in period of more than five years. With regard to the aforementioned interest rates, an analysis was carried out to determine whether there are adjustment differences between banks. However, no clear conclusions can be drawn about differences in the pass-through across the loan categories or about the intensity of competition in the credit markets concerned.

The rates for short-term and long-term corporate loans are reported for various size categories. Up to the end of 2001, the rates reported on current account credit were subdiv-

12 See M Ehrmann and A Worms, *Interbank lending and monetary policy transmission: evidence for Germany,* Economic Research Centre, Deutsche Bundesbank, Discussion Paper 11/01, July 2001.

ided according to loan size into "less than DM200,000", "DM200,000 and over but less than DM1 million" and "DM1 million and over but less than DM5 million".[13] In the case of interest rates on long-term corporate loans, loans of DM200,000 and over but less than DM1 million were distinguished from loans of DM1 million and over but less than DM10 million. In each loan category and size category the reported interest was that agreed for most of the new business or renewals in the middle two weeks of each month. The bank interest rate data are therefore not available at the level of individual loans but are modal values in the categories concerned.

Selection of market rates

As data on bank interest rates are collected each month, monthly average market rates were used as the reference rates. The criterion for the selection of market rates was a comparable maturity. Up to June 1996 the Frankfurt overnight rate was taken as the reference rate for the short-term current account credit rates, which are dependent on the money market; up to December 1998 the Fiona rates were used and from January 1999 the Eonia rates. For long-term corporate lending rates, the yield on German fixed-rate bearer debt securities outstanding was taken as the reference rate. The yield on German debt securities outstanding with a mean residual maturity of more than four and up to five years was selected as the reference rate for the fixed mortgage rate locked in for five years.

Bank classification

In order to test for differences in the lending rate response across banks, some 350 institutions which reported lending rates in the period under review were classified according to size, this being determined by the balance sheet total. Banks were also classified according to their savings deposits in relation to their total liabilities and on the basis of the share of long-term business with non-banks in their balance sheet total. With respect to the period under review, average balance sheet indicators have been calculated for each bank. Based on the distribution of these indicators, bank categories comprising a roughly similar number of banks were established (see the table on page 56).

Measuring the pass-through

The stickiness of bank lending rates was estimated using an error correction model.[14] With regard to a simple model with monopolistic competition, it was assumed that the factors influencing the equilibrium mark-up between the lending rate and the market rate, in particular the bank's borrower and risk structure, do not change during the period under review. The estimated model provides information on short-term interest rate dynamics and on the adjustment to the equilibrium loan mark-up. It regresses the change in the bank lending rate on the lending rate changes in the previous months and on contemporary and lagged changes in the market rate. In addition to these variables, an error correction term reflects the adjustment to the long-run equilibrium loan mark-up. It de-

13 Up to November 1996 the reported current account lending rates were subdivided into two categories only: "less than DM1 million" and "DM1 million and over but less than DM5 million".

14 The methodology used in the empirical analysis is explained in the annex. In particular, the error correction model and its application to a panel of interest rate data is described.

Bank classification

Balance sheet characteristic	Category 1	Category 2	Category 3
Bank size (balance sheet total)	More than €2.7 bn	Between €0.5 bn and 2.7 bn €	Up to €0.5 bn
Savings deposits [1]	More than 37%	Between 28% and 37%	Up to 28%
Long-term non-bank business [2]	More than 94%	Between 75% and 94%	Up to 75%

1 In relation to the bank's total liabilities. — **2** Total of long-term non-bank loans and deposits relative to the balance sheet total.

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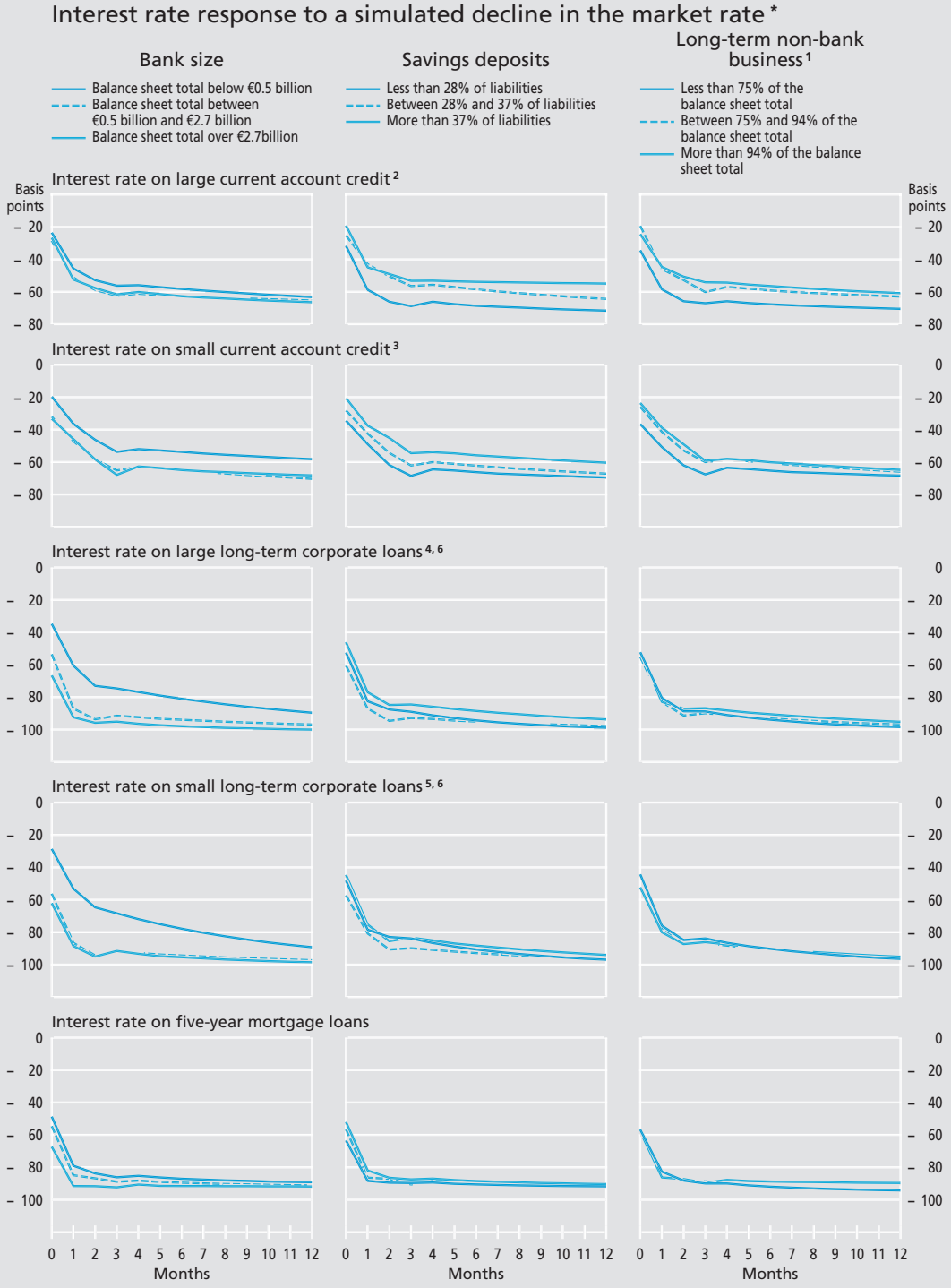
scribes the gap between the actual loan mark-up and the long-run equilibrium loan mark-up. This equilibrium mark-up is not directly observable. It was approximated for each interest rate reporting bank by the average mark-up in the period under review. In order to test empirically whether the aforementioned balance sheet characteristics affect the adjustment of the lending rates to their equilibrium, the interest rate reporting banks were classified according to the balance sheet indicators described above. Pass-through estimations were carried out for each category of bank.[15] The speed of adjustment in the upper and lower bank categories, as derived from the estimation coefficients, was then compared.

Empirical results

The table on page 61 shows the estimated long-run pass-through and the estimated speed of adjustment for the upper and lower categories.[16] The long-run interest rate relationships consistently have the expected sign and are invariably statistically significant. Given the formulated hypotheses, the differences in the adjustment process between the various bank categories have the expected sign in almost every case. The adjustment differences between the upper and lower categories are significant in the majority of cases.[17] As expected, differences in the long-run equilibrium relationship between lending and market rates are insignificant in almost all estimations. This suggests that, irrespective of their adjustment process, apart from a constant bank-specific mark-up, all interest rate reporting banks achieve the same long-run relationship. It is nonetheless striking that only a weak long-term pass-through occurs for current account credit rates: in many cases a fall in the market rate simply leads to a decline in the lending rates of roughly 70%. This is possibly attributable to an incomplete interest rate cycle in the money market in the estimation period with a distinct fall in interest rates (see the chart on page 51). Long-term lending rates, for which, in the period under review, there is a more balanced ratio

15 Depending on the significance of the lagged variables, two or three lags were taken into account.
16 For an extensive presentation of these and other results, see M A Weth, *op cit*.
17 This applies, in particular, to the coefficients for the adjustment to the long-run equilibrium (loading coefficients), but is less clear for responses after one month. See also the table on p 61 and the explanations given in the annex. However, savings deposits and long-term non-bank business have no distinguishing power in terms of the short-run pass-through of long-term corporate lending rates. They differ from one another, however, in their loading coefficients.

Interest rate response to a simulated decline in the market rate *



* Change in the lending rate from its initial level after a decline in the market rate of 100 basis poins. Immediate responses by interest rate reporting banks and the pass-through elasticities for months 1 to 12 after the decline in the market rate are shown in the graphs. The interest rate reporting banks were grouped into three categories according to size; each category contained roughly the same number of banks. — **1** Outstanding loans to non-banks and deposits held by non-banks with agreed maturities of more than one year. — **2** Credit of DM1 million and more but less than DM5 million. — **3** Credit of less than DM1 million; since November 1996: credit of DM200,000 and more but less than DM1 million. — **4** Loans of DM1 million and more but less than DM10 million. — **5** Loans of DM200,000 and more but less than DM1 million. — **6** Loans with interest rates locked in for more than five years.

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of rising and falling market rates, tend, however, to absorb the full extent of changes in the underlying market rate over the long run.

Adjustment paths point to differences ...

The adjustment paths of the lending rates in the first 12 months after a simulated 1% market rate decrease suggest the following (see the chart on page 57):

... with regard to bank size, ...

– Larger credit institutions adjust their credit terms to changes in market rates more quickly than smaller credit institutions. This might be explained by the fact that smaller credit institutions, whose customers rely more on bank loans, need to compete less with market conditions.

... the role of savings deposits ...

– Those banks which use savings deposits as a major means of refinancing adjust their lending rates to changes in market rates comparatively slowly. Despite increasingly differentiated interest rates in the period under review, sizeable savings deposit holdings constituted a relatively stable refinancing basis, permitting greater interest rate adjustment. Banks which have few savings deposits relative to their liabilities align their credit terms far more closely with money and capital market rates.

... and the extent of long-term business with non-banks

– Those banks with a major share of long-term non-bank business adjust their lending rates comparatively slowly to changes in the market rates. A possible interpretation is that the extent of the long-term non-bank business gives some insight into the importance of "housebank relationships".

Summary and conclusions

Structural differences in the interest rate pass-through

The results of the econometric analysis of lending rates taken from the Deutsche Bundesbank's banking statistics reveal structural differences in the way banks respond to changes in interest rates in the money and capital markets. In line with the literature and theoretical considerations, the empirical results for the period from 1993 to 2000 confirm that there is a connection between balance sheet features of German credit institutions and the adjustment of their lending rates in response to monetary policy measures. In most cases a delayed interest rate response was associated with smaller-sized banks, more stable refinancing conditions and a high proportion of long-term non-bank business. However, the extent to which the effect of these variables is interdependent was not analysed. As expected, however, in terms of the long-run relationship between lending and market rates, there were by and large no significant differences across banks. The impact of bank lending rate changes on the corresponding loan volumes was not analysed. An empirical investigation of this, in addition to the pass-through analysis carried out in this study, could help to complete the picture of the monetary policy implications of bank lending rate stickiness.

Annex

The following error correction model is used to determine the pass-through of market rates to bank lending rates:

$$\Delta r_t = \sum_{k=1}^{K} \varphi_k \Delta r_{t-k} + \sum_{q=0}^{Q} \omega_q \Delta m_{t-q} + \alpha [r_{t-1} - \beta m_{t-1} - C] + \varepsilon_t$$

In this specification it is assumed that, in addition to its values in the previous periods, the lending rate r is determined solely by an exogenous market rate. The error term ε_t is normally distributed and not serially correlated. The dependent variable is the change in the lending rate Δr_t. The estimation model includes an error correction term $[r_{t-1} - \beta m_{t-1} - C]$ which describes the adjustment of the lending rate r to its long-run equilibrium mark-up C on the market rate, as well as lagged variables which capture information about the short-term dynamics of the lending rate. The application of this estimation method presumes the existence of a stationary long-run mark-up between the lending rate and the market rate, that is of an equilibrium interest rate relationship C. Stationarity means that this relationship has no trend and is thus constant over time. This model is estimated for a panel of banks:

$$\Delta r_{i,t} = \mu_i + \sum_{k=1}^{K} \varphi_k \Delta r_{i,t-k} + \sum_{q=0}^{Q} \omega_q \Delta m_{t-q} + \alpha [r_{i,t-1} - \beta m_{t-1}] + \varepsilon_{i,t}$$

Here a bank-specific equilibrium mark-up is introduced which is part of the constant μ_i. This equilibrium mark-up is approximated for each bank i by the average mark-up over the period under review. This estimation method (known as the within estimation with fixed effects) is based on the assumption that the lending rate change $\Delta r_{i,t}$ of bank i has the same determinants as the other banks except for a systematic level shift that is constant over time. This implies the assumption that other factors influencing the equilibrium mark-up, particularly the bank's cost and risk structures, remain unchanged in the estimation period.

The model provides a loading coefficient α and a pass-through elasticity. The loading coefficient contains information about the speed of adjustment to the temporary deviation from the long-run level relationship and must be significantly negative if the assumption of a stationary equilibrium mark-up is substantiated. The pass-through elasticity indicates the percentage of a simulated market rate shock reflected in the lending rate after t periods. Accordingly, in the period following a 1% change in the market rate ($\Delta m_{t-1} = m_{t-1} = 1$) a pass-through elasticity of $a = \varphi_1\omega_0 + \omega_1 + \alpha\omega_0 - \alpha\beta + \omega_0$ results if the immediate lending rate change corresponds to the level of the lending rate in the preceding period, ie $\Delta r_{t-1} = r_{i,t-1} = \omega_0$. To calculate this pass-through elasticity, the loading coefficient α is therefore required.

For the period under review, average balance sheet indicators are calculated for each bank. Based on the distribution of these indicators, three bank categories each containing a roughly similar number of banks are then derived. Subsequently, error correction estimations are carried out which take the following form:

$$\Delta r_{i,t} = \mu_i + \sum_{n=1}^{3} \left\{ \sum_{k=1}^{K} \varphi_{n,k} \Delta r_{i,t-k} D_{i,n} + \sum_{q=0}^{Q} \omega_{n,q} \Delta m_{t-q} D_{i,n} - \alpha_n [r_{i,t-1} - \beta_n m_{t-1}] D_{i,n} \right\} + \varepsilon_{i,t}$$

where $D_{i,n} = \begin{cases} 1 \text{ if } i \in \text{ category n, n = 1,2,3} \\ 0 \text{ otherwise} \end{cases}$

This estimation approach is based on the assumption that although the banks differ from one category to another in terms of their response parameters – albeit with the exception of the bank-specific constant, which reflects their long-run mark-up – they do not differ within a category. Changes in the balance sheet structure over time are not taken into account. The dummy variable D_1 of category 1 thus assumes the value of 1 if the interest rate reporting bank records an average balance sheet characteristic which is to be assigned to the upper bank category. Otherwise, the dummy variable 1 in category 1 has the value of zero. Much the same applies to the dummy variables in categories 2 and 3. Interaction terms are then defined for all model variables as the product of the dummy variables of one category and each model variable. The interaction term thus equals the model variable if the interest reporting bank is to be assigned to the respective category.

This approach permits an estimation and a comparison of the differences across the bank categories to be made in terms of the loading coefficient and pass-through elasticity, all of which describe their interest rate setting behaviour, as well as with respect to the long-run relationship between lending and market rates. The latter equilibrium mark-up is important in terms of the implication of the estimates. In order to allow a comparison between the adjustment processes – ie between the pass-through elasticities or between the loading coefficients – the coefficients β, capturing the long-run relationship, should not differ significantly across banks. If, in the long run, not all banks achieve a similar interest rate relationship, the adjustment paths are not comparable either. Only if all banks achieve the same long-run relationship – apart from the bank-specific mark-up – does the model provide information about adjustment differences between banks. It is assumed that each bank does not have a different adjustment path and that the lending rates within the bank categories respond similarly to changes in the market rate. In order to test for differences between the estimated pass-through measure x_1 of the upper bank category and the estimated pass-through measure x_3 of the lower bank category, the variance of the function $x_1–x_3$ is estimated using the delta method.[18] Assuming asymptotic normal distribution, the null hypothesis H_0: $x_1–x_3 = 0$ is tested.

The interest rate series are subjected to an adjustment for outliers. The problem posed by outlier values in the data is that, in the within estimations with fixed effects, high absolute levels of the model variables are weighted more heavily than low levels. Hence those outlier values which are more than four times the standard deviation from the average are eliminated. Moreover, the minimum length of the bank time series is defined as 20 consecutive monthly interest rate reports. For reasons of asymptotics, this is necessary in the error correction estimates performed here. If a time series with a break is available for a bank, two separate time series are generated from the bank's original time series.

Overall, in the period under review, more than 200 takeovers and mergers took place among the interest rate reporting banks, where the bank which existed after the takeover or merger reported interest rates to the Bundesbank. A takeover or merger can, in principle, lead to a change in lending rate policy or, owing to changed customer patterns, to a new lending rate level. Hence, in the

18 See F Hayashi, *Econometrics,* Princeton, 2000.

Adjustment processes and long-run interest rate relationships – test for differences between banks

Differences significant at the 10% level (*), the 5% level (**) and the 1% level (***)

Balance sheet characteristic and interest rate type	One-month pass-through elasticity [1]			Loading coefficient α [1]			Long-run interest rate relationship β [1]		
	Bank category 1 (x1)	Bank category 3 (x3)	Difference [2] x1 – x3	Bank category 1 (α1)	Bank category 3 (α3)	Difference [2] $\lvert\alpha 1\rvert - \lvert\alpha 3\rvert$	Bank category 1 ($-\beta 1$)	Bank category 3 ($-\beta 3$)	Difference [2] $\beta 1 - \beta 3$
Bank size	Category 1: balance sheet total > €2.7 bn; Category 3: balance sheet total < = €0.5 bn								
Expected sign	+	+	+	–	–	+	–	–	–/+
Interest rate on large current account credit [3]	0.52	0.45	0.07	– 0.18	– 0.10	0.07**	– 0.69	– 0.70	– 0.01
Interest rate on small current account credit [4]	0.45	0.36	0.09**	– 0.13	– 0.08	0.04**	– 0.73	– 0.66	0.06
Interest rate on large long-term corporate loans [5]	0.91	0.60	0.32***	– 0.24	– 0.09	0.15***	– 0.99	– 1.08	– 0.09
Interest rate on small long-term corporate loans [6]	0.88	0.52	0.36***	– 0.19	– 0.13	0.07*	– 0.99	– 0.89	0.10
Mortgage rate [7]	0.91	0.78	0.13***	– 0.22	– 0.24	– 0.02	– 0.91	– 0.89	0.02
Savings deposits	Category 1: savings deposits > 37% of liabilities; Category 3: savings deposits < = 28% of liabilities								
Expected sign	+	+	–	–	–	–	–	–	–/+
Interest rate on large current account credit [3]	0.44	0.58	– 0.14**	– 0.09	– 0.16	– 0.06**	– 0.56	– 0.74	– 0.19**
Interest rate on small current account credit [4]	0.37	0.48	– 0.11**	– 0.05	– 0.13	– 0.08***	– 0.74	– 0.73	0.01
Interest rate on large long-term corporate loans [5]	0.76	0.81	– 0.05	– 0.10	– 0.23	– 0.13***	– 1.04	– 0.95	0.09
Interest rate on small long-term corporate loans [6]	0.75	0.77	– 0.03	– 0.12	– 0.20	– 0.08**	– 1.02	– 0.95	0.07
Mortgage rate [7]	0.81	0.87	– 0.06***	– 0.20	– 0.28	– 0.07**	– 0.91	– 0.92	– 0.01
Long-term non-bank business	Category 1: long-term non-bank loans and deposits > 94% of the balance sheet total; Category 3: long-term non-bank loans and deposits < = 75% of the balance sheet total								
Expected sign	+	+	–	–	–	–	–	–	–/+
Interest rate on large current account credit [3]	0.43	0.58	– 0.14**	– 0.10	– 0.15	– 0.05*	– 0.69	– 0.73	– 0.04
Interest rate on small current account credit [4]	0.38	0.50	– 0.12**	– 0.06	– 0.14	– 0.08***	– 0.77	– 0.71	0.06
Interest rate on large long-term corporate loans [5]	0.82	0.79	0.03	– 0.10	– 0.21	– 0.11**	– 1.04	– 0.98	0.06
Interest rate on small long-term corporate loans [6]	0.79	0.75	0.05	– 0.12	– 0.19	– 0.07*	– 1.01	– 0.95	0.06
Mortgage rate [7]	0.85	0.81	0.04	– 0.20	– 0.31	– 0.11***	– 0.81	– 0.86	– 0.05**

1 One-month pass-through elasticities, loading coefficients and long-run interest rate relationships are invariably significant. — **2** Test for equality: H_0: x1 – x3 = 0 or $\alpha 1 - \alpha 3 = 0$ and $\beta 1 - \beta 3 = 0$. — **3** Credit of DM1 million and over but less than DM5 million. — **4** Credit of less than DM1 million; since November 1996: credit of DM200,000 and over but less than DM1 million. — **5** Long-term loans to enterprises and self-employed persons of DM1 million and over but less than DM10 million with interest rates locked in for more than five years. — **6** Long-term loans to enterprises and self-employed persons of DM200,000 and over but less than DM1 million with interest rates locked in for more than five years. — **7** Interest rate charged on mortgage loans with interest rates locked in for five years.

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case of a merger or takeover, two separate time series were derived from the original time series for an interest rate reporting bank effecting the takeover – first, up to the takeover date and, second, from the takeover date.