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

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Abstract

The terms and conditions on which bank loans are made to non-financial firms and households play a key role in the transmission of monetary policy. This paper analyses the relationship between German bank lending rates and both money market and capital market rates in the 1990s. This study reveals evidence of structural differences in the interest rate pass-through across German banks. The speed at which bank lending rates adjust to changes in market rates is related to a credit institution's size, its refinancing conditions and the extent of its business with non-banks. Large banks and banks with few savings deposits adjust their lending rates to market terms more quickly than other banks, possibly because their scope for setting interest rates is comparatively narrow. A fairly small amount of long-term business with non-bank customers, indicating the importance of relationship banking, also leads to a faster lending rate pass-through. In the short run, lending rates are stickier for banks that are largely able to cover their long-term loans to non-banks by corresponding deposits from such clients. Finally, the lending rates charged on corporate loans at a number of banks – especially those for current account credit – respond only gradually to changes in market rates. By smoothing their rates, banks appear to accept temporary fluctuations in their loan mark-up. This, in turn, tends to retard monetary policy transmission via bank rates. In the long-run relationship between lending and market rates, however, apart from a constant bank-specific mark-up, there are, in most cases, no differences across banks. This suggests that a similar long-run pass-through obtains for all interest rate reporting banks, irrespective of the adjustment process.

Zusammenfassung

Den Kreditkonditionen von Banken kommt eine bedeutende Rolle im geldpolitischen Transmissionsprozess zu. Die vorliegende empirische Studie untersucht den Zusammenhang zwischen Kreditzinsen deutscher Banken und den Bedingungen am Geld- und Kapitalmarkt in den neunziger Jahren. Die präsentierten Schätzungen unterstreichen, dass sich die Zinsreaktionen verschiedener Kreditinstitute strukturell unterscheiden. Die Studie zeigt, dass das Anpassungstempo der Kreditzinsen an veränderte Marktzinsen von der Größe der Banken, ihren Refinanzierungsbedingungen und der Bedeutung ihres Nichtbankengeschäfts abhängt. Große Institute und Banken mit einer geringen Refinanzierung durch Spareinlagen passen ihre Kreditzinsen schneller als andere Institute an Marktzinsen an, was auf einen geringeren Zinssetzungsspielraum zurückgeführt werden kann. Sind die langfristigen Einlagen- und Kreditgeschäfte mit Nichtbanken, die als Indikator für das Relationship Banking des Instituts herangezogen werden, vergleichsweise moderat, so geht dies ebenfalls mit einer zügigen Zinsreaktion einher. Bestehen dagegen starke Beziehungen zwischen der Bank und ihren Kunden, so kann sich die Bank eine verzögerte Zinsanpassung eher leisten. Schließlich reagieren Kreditzinsen derjenigen Banken in der kurzen Frist träger auf Marktzinsänderungen, die ihre längerfristigen Nichtbankenkredite großenteils durch entsprechende Nichtbankeneinlagen finanzieren können. Vor allem bei Unternehmenskrediten und hierunter besonders bei Kontokorrentkrediten reagieren die Kreditzinsen einer Reihe von Banken nur schrittweise auf veränderte Marktzinsen. Durch die Zinsglättung nehmen diese Institute vorübergehende Schwankungen ihres Zinsabstands zum Marktzins in Kauf. Dadurch verzögert sich der geldpolitische Transmissionsprozess über Bankzinsen. Sieht man von einem bankspezifischen, zeitkonstanten Zinsabstand ab, so bestätigen sich Unterschiede in der langfristigen Beziehung zwischen Kredit- und Marktzinsen in den meisten Fällen nicht. Das spricht dafür, dass alle zinsmeldenden Banken trotz unterschiedlicher Anpassungsverläufe langfristig ein ähnliches Anpassungsniveau erreichen.

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

I. Introduction

The pass-through from money market and capital market rates to bank interest rates has attracted particular attention in the light of competition in the banking sector over the past few years. The pass-through has been discussed, in particular, in the context of monetary policy since the transmission of market rates to bank retail rates is an important element in the monetary transmission process. A common finding is that market conditions are not passed on to bank interest rates immediately. The empirical literature provides evidence that corporate lending rates, in particular, respond sluggishly to market rates; see, among other papers, the multi-country analyses of Cottarelli and Kourelis (1994), Borio and Fritz (1995) and Mojon (2000). These authors discuss different country-specific pass-through determinants, including the stage of financial market development, the degree of financial market openness and the concentration within the banking sector. Other studies, such as Cottarelli, Ferri and Generale (1995), Angeloni, Buttiglione, Ferri and Gaiotti (1995) and Berlin and Mester (1999), explain the pass-through from market rates to Italian and US bank lending rates in terms of bank size, relationship banking and liability structure, all of which the authors take as proxies for competition among banks. In line with the views expressed in these papers, this paper takes as its starting point the idea that bank balance sheet structure is linked to the extent to which a bank can isolate its lending rate policy from the development of market conditions. The paper evaluates the lending rate changes made by German banks in the 1990s, some of which differ considerably. Existing studies of the pass-through from market interest rates to German bank-retail rates analyse aggregate interest rate data only, i.e. averages of bank survey data. The use of disaggregate data allows more detailed conclusions on lending rate stickiness to be drawn. In particular, I analyse structural differences across German banks using five rates for different types of bank lending taken from the Deutsche Bundesbank interest rate statistics.[1] These are short-term and long-term corporate lending rates, for two loan size categories each, and a

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1 Analysis of the interlinkage between the lending rate pass-through and the borrowers' risk characteristics is beyond the scope of this study.

mortgage rate. The latter is added to allow a comparison to be made between corporate lending rate adjustment and the lending rate response of other non-bank loans.

The paper concludes that structural differences in the lending rate pass-through across banks exist, but not to the same extent for all bank classifications and in all interest rate types. The main finding is that banks respond to changes in market rates depending on their size, the volume of their savings deposits and their long-term business with non-banks. To summarise, lending rates are stickier for small banks, banks with high savings deposits and banks with a high volume of non-bank business. Looking at the refinancing conditions applied to long-term loans to non-banks, significant structural differences only matter in the short run: banks whose long-term loans to non-banks are largely covered by long-term non-bank deposits react more sluggishly in the short run. The pass-through to mortgage rates differs less considerably across the board, whereas a differential reaction turns out to be more accentuated for corporate lending rates, in particular for those applied to current account credit. With respect to the long-run relationship between market and lending rates, the balance sheet indicators under review have, for the most part, no distinguishing power.

The paper is structured as follows. First, the intuition of several propositions relating to the lending rate pass-through is outlined on the basis of the existing literature and plausibility considerations. Section III presents the econometric approach and highlights its underlying assumptions. After describing the data set in section IV, section V presents the results of the panel estimations. Section VI concludes.

II. The conceptual framework

A starting-point for looking at the lending rate pass-through is the mark-up between the bank rate and the money market rate and between the bank rate and the bond market rate with a comparable maturity. The interest rate differential that is achieved at the end of an adjustment process is called the equilibrium mark-up. However, its determinants are not discussed in this paper.[2] Instead, the present paper analyses the adjustment process of bank lending rates to their equilibrium mark-up, approximated to by the average loan mark-up per bank in the period under review. Thus all determinants of the equilibrium mark-up, in particular the riskiness of the bank's portfolio and the creditworthiness of its borrowers, are assumed to be

2 For a discussion of mark-up models, see Lowe (1994), Berlin and Mester (1999) and Corvoisier and Gropp (2001). For discussions of the interest rate margin, see Ho and Saunders (1981), Allen (1988), Moore (1988), Zarruk (1989), Wong (1997), Angbazo (1997) and Saunders and Schumacher (2000).

constant over time.[3] The analysis points to the speed and the extent to which bank lending rates respond to changes in the market rate. I focus on the question of whether the adjustment behaviour of German banks coincides with a specific balance sheet pattern. To test for structural differences in the pass-through across banks, I classify the interest rate reporting banks according to four propositions. Pass-through estimations are then carried out. Finally, the estimation results are tested for equality across bank categories.

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, larger interest rate changes over continuously adjusting interest rates. In addition, shifts in credit demand[4] and changes in the banks' competitive position can influence the 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 may 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 pace 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 faster in times of rising interest rates.[5] On the basis of the data available, an empirical analysis of this asymmetry is, however, impossible to carry out, because the data cover a too short a period of time (April 1993 to December 2000).

The refinancing conditions of credit institutions are frequently stressed as a factor influencing their lending rate. As the value-added by a bank consists of risk transformation, the bank demands from its borrowers a premium on its refinancing costs for managing the risks posed by its lending activities. Other things being equal, the bank will adjust its terms for new credit contracts if the conditions of its own refinancing change. A distinction can be made between banks with market-related refinancing costs and banks whose refinancing conditions depend to a lesser extent on movements in market rates. This distinction owes something to Berlin and Mester (1999), who regard the share of low-interest-bearing bank deposits as an indicator

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3 Moreover, a sufficiently long investigation period is presupposed when determining the equilibrium mark-up. However, the period under review (1993 to 2000) comprises an incomplete interest rate cycle, especially in the money market. Hence the approximation of the equilibrium mark-up by the average mark-up during that period could lead to less precise results, especially for current account credit rates.

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

5 See Borio and Fritz (1995).

of the market power of banks on the deposit side.[6] Similarly to Berlin and Mester, I contend that banks who heavily depend on money market or capital market financing will adjust their lending rates more quickly than banks whose liabilities are little affected by market movements. 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 a typical category of deposits, whose interest rates are comparatively little affected by the market rate movements. They are mainly available to banks as longer-term deposits.[7] Institutions which resort extensively to these kinds of deposits for refinancing purposes feel less pressurised to adjust their lending rates promptly than institutions whose refinancing costs increase at the same time and to a similar extent as market rates. On the basis of these considerations I test for adjustment differences between banks with substantial savings deposits relative to their liabilities and those with few savings deposits.

The argument of stable refinancing conditions can also be linked to the bank's credit structure. In this case, deposits are seen in the context of the loan maturity structure. The idea is that, given a definite level of long-term deposits with divergent maturities of the loans, banks will probably adjust to changes in market interest rates at different speeds. The less their long-term loans are accompanied by long-term deposits, the greater their need to hedge against interest rate risks, and the more attention will be paid to current market developments.[8] The pressure to adjust the rates charged for newly-extended credits to fluctuating refinancing costs is correspondingly high. This paper therefore examines whether the refinancing conditions of long-term loans to non-banks affects the response of loan conditions to market interest rates. To verify this empirically, the refinancing conditions are defined as the gap between non-bank loans and non-bank deposits, with agreed maturities of more than one year, relative to total non-bank loans.[9] For the reasons stated, savings deposits are added to the non-bank deposits.

On that analogy, I assume that those credit institutions which maintain close ties with their non-bank customers and have market power on account of their customer structure on both

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6 For Berlin and Mester (1999) the ratio of low-interest-bearing deposits to aggregate bank liabilities is, in addition to the Herfindahl index, a measure of the market power of banks in the deposit market. The Herfindahl index, defined as the sum of squared market shares, is a yardstick of horizontal concentration in a market. See Neuberger (1998), p. 81 f.

7 Hein (1993) designates four-fifths of savings deposits as stable. See Hein (1993), p. 139.

8 Interest rate risks associated with the bank's lending activity are hedged by means of interest swaps. This suggests a market-oriented adjustment of the interest rates charged for new business.

9 An indicator defined thus has the advantage in terms of maturity that, despite the restructuring of the Bundesbank's bank balance sheet statistics at the end of 1998, it is available for the entire period under investigation. Admittedly, a division into short-term and longer-term loans should be carried out not on the basis of the original maturity but on the basis of the residual maturity. As such data are not available in the Bundesbank's bank balance sheet statistics, original maturities are used as a distinctive feature.

the deposit side and the loan side have scope for interest rate smoothing.[10] In Germany relationship banking, i.e. a lasting relationship between a bank and its customers, is closely linked to the "housebank" principle: a customer's "housebank" has the best information on the customer's creditworthiness and therefore acts as the customer's principal lender.[11] Since the "housebank" status of the banks reporting interest rates is not observable, it is approximated in the present study by the share of long-term non-bank business in the balance sheet total. Long-term non-bank business is calculated as the total of loans to non-banks and deposits by non-banks with agreed maturities of more than one year. The thinking behind this is that a bank with a relatively extensive, longer-term non-bank business maintains closer relationships with its customers and therefore acts more as a "housebank" than one whose long-term non-bank business is only of minor importance.[12] The information advantage over the capital market and other banks resulting from a close bank-customer relationship prompts the bank to offer an insurance-like implicit contract: whereas the borrower faces a reduced financing risk, the bank benefits from a monitoring at low cost.[13] Berger and Udell (1992) suggest that interest rate smoothing could follow on from splitting risk between the bank and its customers. The proposition to be empirically tested is that banks which are heavily involved in long-term business with non-banks adjust their lending rates comparatively slowly.

Another determinant that is frequently discussed in the literature on monetary policy transmission is bank size. According to the credit view, the size of a credit institution reflects its ability to access alternative sources of refinancing, and thus to offset the effects of monetary policy measures. Accordingly, small banks, whose holdings of deposits decline following a monetary policy tightening, are unable to raise any additional finance in the market to keep their lending at a high level.[14] Contrary to this, most German small banks have access to alternative sources of finance, as they are organised in a sector which permits them to access financing through their central institutions.[15] This could explain why the refinancing

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10 See Berlin and Mester (1999), Hannan and Berger (1991) and Cottarelli et al. (1995).

11 See Elsas and Krahnen (1998).

12 It is conceded that this indicator is imprecise insofar as it does not distinguish between credit institutions with a "housebank" status and other institutions geared to retail business with non-banks.

13 See Petersen and Rajan (1994), Thakor (1995), Allen and Gale (1995) and Allen and Gale (1997). According to Allen and Gale (1997), growing competition among the banks would reduce the advantages of such long-term contractual relations between a bank and its customers. Elsas and Krahnen (2000) draw attention to the fact that the quality of such an insurance-like contract is closely linked to its collateralisation.

14 See Kashyap and Stein (2000). In the context of the lending rate pass-through, Cottarelli et al. (1995) and Angeloni et al. (1995) find that large banks adjust their lending rates to monetary policy changes faster than other banks.

15 Ehrmann and Worms (2001) find evidence of the significance of size in the German interbank market only if those banks belonging to a banking federation can refinance themselves intra-sectorally through their central institutions are disregarded. In the sample of interest rate reporting banks, most banks that are classified as "small" are savings banks or cooperative banks. But also among banks classified as "large", banks belonging to a banking federation make up two-thirds of all institutions. See Table A.4 in Annex A.

conditions of many small banks are more stable. For this reason it is possible that, in contrast to the credit view, the lending rates of small banks respond less to market rate increases than those of large banks.[16] For Germany, bank size is therefore not a reliable indicator of the availability of alternative forms of refinancing.[17] However, bank size reflects the institutional structure and thereby the dependence of a bank's refinancing conditions on market terms. Nonetheless, a certain correlation between the size of a bank and that of its borrowers may well exist. This could, in turn, influence its interest rate setting behaviour. The underlying assumption is that larger banks compete as capital providers with those acting in the money market and the capital market. The bank therefore sets its lending rate not only in relation to the competition among banks,[18] but also in relation to the competition with market terms. Whereas large banks can focus more on lending to larger enterprises that have alternative means of raising finance in the market, it can be assumed that borrowers from small banks are frequently small and medium-sized enterprises, which are more dependent on bank loans. As a rule, this is likely to be reflected in larger banks setting lending rates more closely in line with market conditions. If most of a bank's borrowers have access to sources of finance in the money market and the corporate bond market, the bank will quickly adjust its lending rates to market terms so as not to lose customers. Thus its scope for to keeping to constant lending rates is limited, whereas smaller banks have greater flexibility in this respect. Bank size would therefore be significant mainly in terms of corporate lending. One possible reason for this difference in market access between borrowers of small and large banks is the improved financing of large firms in the money market or the corporate bond market in the course of the 1990s.

III. Methodology

1. Measuring the pass-through

The stickiness of the lending rate adjustment is estimated by an error correction model. This approach is based on the following ideas. Standard economic theory implies that, in a monopolistic competition environment, the bank lending rate should be, in the long run, related to the level of a market rate, that reflects the marginal yield of a risk-free investment.[19] It is presumed that the determinants of the equilibrium mark-up, in particular the borrower

16 A similar result has been found for Italy by Angeloni et al. (1995). They find evidence of a credit channel, but no size effects that correspond to the credit view.

17 See Ehrmann und Worms (2001).

18 See Hannan and Berger (1991) and Cottarelli et al. (1995).

19 See Klein (1971).

structure and the risk structure of the bank, does not change during the period under review.[20] However, the short-run relationship between lending and market rates is subject to lags, relating to lending rate rigidities.[21] A common representation of the dynamic lending rate determination process is the autoregressive distributed lag (ADL) model, as suggested by Kremers, Ericsson and Dolado (1992) and by Pesaran and Shin (1999).

$$(1) \qquad r_{i,t} = const_i + \sum_{k=1}^{4} \alpha_k \, r_{i,t-k} + \sum_{q=0}^{4} \beta_q m_{t-q} + \varepsilon_{i,t}$$

where $\varepsilon_{i,t} \sim IID\left(0, \sigma_\varepsilon^2\right)$

In this specification, it is assumed that the lending rate $r_{i,t}$ of bank i in month t, besides its lagged values, depends exclusively on market rates. Applying the ADL model (1) relies on the key assumption that there is a stationary long-run relationship between the two interest rates, which is sometimes referred to as the steady state. Thus an equilibrium loan mark-up must exist. In the specification of equation (1), four lagged endogenous variables $r_{i,t-k}$, and one contemporary and four lagged exogenous market rate variables m_{t-q} are included. The error term $\varepsilon_{i,t}$ is not serially correlated and independent across banks. The stability of the long-run relationship requires $(\beta_0+\beta_1+\beta_2+\beta_3+\beta_4)$ to be positive and $(\alpha_1+\alpha_2+\alpha_3+\alpha_4)$ to be smaller than one. These are the stationarity conditions of the equilibrium mark-up. The error correction representation of equation (1) is:

$$(2) \qquad \Delta r_{i,t} = \mu_i + \sum_{k=1}^{3} \varphi_k \Delta r_{i,t-k} + \sum_{q=0}^{3} \varpi_q \Delta m_{t-q} + (\delta+\gamma)\left[r_{i,t-1} - \gamma/(\delta+\gamma)\, m_{t-1}\right] + \varepsilon_{i,t}$$

and

$$(3) \qquad \Delta r_{i,t} = \mu_i + \sum_{k=1}^{3} \varphi_k \Delta r_{i,t-k} + \sum_{q=0}^{3} \varpi_q \Delta m_{t-q} + \gamma\left[r_{i,t-1} - m_{t-1}\right] + \delta r_{i,t-1} + \varepsilon_{i,t}$$

where

$$\varphi_1 = -(\alpha_2+\alpha_3+\alpha_4),\ \varphi_2 = -(\alpha_3+\alpha_4) \text{ and } \varphi_3 = -\alpha_4$$

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20 See, for example, Cottarelli and Kourelis (1994). Loan demand is assumed to remain stable, too.

21 Such rigidities could be due to adjustment costs, the uncertainty of banks about the future development of general market rates and, among other factors, the determinants that are tested in this paper (see chapter II).

$$\varpi_0 = \beta_0, \varpi_1 = -(\beta_2 + \beta_3 + \beta_4), \varpi_2 = -(\beta_3 + \beta_4) \text{ and } \varpi_3 = -\beta_4$$

$$\gamma = -(\beta_0 + \beta_1 + \beta_2 + \beta_3 + \beta_4)$$

$$\delta = -(1 - \alpha_1 - \alpha_2 - \alpha_3 - \alpha_4) + (\beta_0 + \beta_1 + \beta_2 + \beta_3 + \beta_4)$$

Equation (3) describes a panel error correction model with a bank-specific effect μ_i, three lagged endogenous lending rate changes and one contemporary and three lagged exogenous market rate changes. The criterion on which this specification is based is that all significant lags are included in the panel regression. The long-run relationship between the lending rate and the market rate corresponds to $\gamma/(\gamma+\delta) = (\beta_0+\beta_1+\beta_2+\beta_3+\beta_4) / (1-\alpha_1-\alpha_2-\alpha_3-\alpha_4)$. For $(\beta_0+\beta_1+\beta_2+\beta_3+\beta_4)>0$ and $(\alpha_1+\alpha_2+\alpha_3+\alpha_4)<1$, γ and $(\gamma+\delta)$ are negative, which is crucial for an equilibrium relationship between the interest rate levels. If δ is insignificant, that confirms a complete pass-though, i.e. a one-to-one long-run relationship between the lending rate and the market rate: $(r_i - c_i) / m = 1$, where the bank-specific mark-up c_i is captured by the individual effect μ_i. If δ is significant, $(r_i - c_i) / m$ equals $\gamma/(\gamma+\delta)$. With respect to the adjustment process, the model provides a loading coefficient and a pass-through elasticity that indicates how many per cent of a simulated change in the market rate is in the lending rate after t periods.[22] Hence, one period after a market rate change from 0 to 1, a pass-through elasticity of $\varphi_1\omega_0 + \omega_1 + (\delta+\gamma)\omega_0 - \gamma + \omega_0$ results for the lending rate if the lagged lending rate change, ω_0, equals the lending rate level of the previous period, or $\Delta r_{t-1} = r_{i,t-1} = \omega_0$. The estimation of this pass-through elasticity requires the loading coefficient of the error correction term, which provides information on the speed of adjustment to the temporary deviation from the level relationship. The loading coefficient corresponds to $(\gamma+\delta) = -(1-\alpha_1-\alpha_2-\alpha_3-\alpha_4)$, and must be significantly negative if the assumption of an equilibrium relationship is correct.[23] The bank-specific equilibrium mark-up is approximated, with recourse to the within-estimation method, by the average loan mark-up for each bank.[24] The underlying assumption is that the interest rate change $\Delta r_{i,t}$ of bank i, in its determinants, does not differ from that of other banks, except for a systematic (non-random) constant individual effect. The assumption of a constant equilibrium mark-up presupposes that its determinants, i.e. the cost and risk structures of credit institutions, remain unchanged during the period under review. The short-run response

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22 By analogy with Mojon (2000), the pass-through elasticity can be obtained from the estimated coefficients of the error correction model. The lending and market rates are initially 0. A permanent change in market rates from 0 to 1, i.e. $\Delta m_{t-1} = m_{t-1} = 1$, is now simulated. The cumulative changes, and thus the level of the lending rate, are computed for every period.

23 See Greene (2000), p. 733 f. and 793 f. and Mojon (2000), p. 9.

24 The fixed-effects within-estimation methodology is described in Annex B. In the within-transformation, the mean of the bank-specific mark-up is captured by the individual effect μ_i,. Thus a constant does not need to be introduced in the error correction term.

of banks is measured in terms of their one-month pass-through elasticity. The speed of adjustment is defined in terms of the loading coefficient ($\delta+\gamma$).

2. Estimation with bank categories

The econometric approach is intended to identify structural differences in interest rate setting behaviour across banks. As described above, I contend that such differences exist in the bank's balance sheet. With respect to the period under review and to the propositions discussed above, average balance sheet indicators are calculated for each interest rate reporting bank. Based on the distribution of these indicators, bank categories comprising a roughly similar number of banks were set up. On this basis, error correction estimations are carried out. Changes in balance sheet structure during that period are left out of account. Thus, the dummy variable of category 1 equals 1 if the bank has an average balance sheet characteristic which belongs to the upper bank category. Otherwise the value 0 is attributed to the dummy variable of category 1. The same applies to the dummy variables of the bank categories 2 and 3. For all model variables, interaction terms are defined as the product of the dummy variable and the respective model variables. Thus the interaction term equals the value of the model variable if the bank belongs to the respective category.[25] The panel error correction model with interaction terms reads:

$$(4)\quad \Delta r_{i,t} = \sum_{n=1}^{3}\left[\sum_{k=1}^{K}\varphi_{n,k}\Delta r_{i,t-k}\ D_{i,n} + \sum_{q=0}^{Q}\varpi_{n,q}\Delta m_{t-q}\ D_{i,n} - \gamma_n\left[r_{i,t-1} - m_{t-1}\right]D_{i,n} + \delta_n r_{i,t-1}\ D_{i,n}\right]$$

$$+\mu_i + \varepsilon_{i,t}$$

where $n = 1,\ 2,\ 3$

$$D_{i,n} = \begin{cases} 1 & \text{if } i \in \text{class } n \\ 0 & \text{if } i \notin \text{class } n \end{cases}$$

Equation (4) corresponds to equation (3), multiplied by the dummy variables $D_{i,1}$, $D_{i,2}$ and $D_{i,3}$.[26] This approach is based on the assumption that banks differ in their estimation coefficients between the categories, but not within the categories, except in their individual effects. This allows a test for pass-through inequalities across bank categories to be carried out

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25 Failing this, the interaction term equals zero.

26 In the case of the current account credit rate in the credit category of under DM1 million, an intervention dummy variable is additionally introduced for each category since the interest rate statistics were switched in November 1996 from the category "credit of less than DM1 million" to the category "credit of DM200,000 and over but less than DM1 million".

with respect to the propositions of this study. To do this, the loading coefficients and pass-through elasticities are computed from each category estimates. Thereafter the difference between the upper category value (x_1) and the lower category value (x_3) is tested under the null hypothesis H_0: $x_1-x_3=0$. On the assumption of asymptotic normal distribution, the variance of the function x_1-x_3 is calculated by means of recourse to the delta method.[27] A condition to compare the banks' adjustment processes is that all banks should converge to the same long-run interest rate relationship, as defined by $-\gamma/(\delta+\gamma)$, except the bank-specific effect. Failing this, the adjustment paths cannot be compared across banks. Therefore a test for differences between the upper category long-run relationship and the lower category long-run relationship is carried out, too.

3. Outliers and incomplete time series

The interest rate time series are adjusted 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 each time series is defined as twenty consecutive monthly interest rate reports. This is necessary in the error correction estimations carried out here on grounds of asymptotics. If, for a bank, breaks occur in its time series, two or more separate time series are generated from the original time series.

IV. Data

The panel-econometric analysis is carried out with interest rate data that were reported to the Deutsche Bundesbank on a monthly basis by about ten per cent of German banks from April 1993 to December 2000. These interest rate reporting banks were selected from among the credit institutions which conduct banking business, as defined in Section 1 (1) of the Banking Act, which have their registered office in the Federal Republic of Germany, and which, as monetary financial institutions, are required to report their balance sheet positions monthly to the Deutsche Bundesbank. The Deutsche Bundesbank collects interest rate data from about 350 credit institutions of different size, different sectors and different regions in Germany (focussing on the regional centres of German banking business).[28] Some of the larger branch banks do not report a single interest rate, but interest rates of a number of their branches. In the present paper, the branch reports of larger banks are aggregated to form an average rate at

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27 See Hayashi (2000), p. 93 f.

28 See Annex A.1.

bank level. The bank interest rate data of the Deutsche Bundesbank are not available at the level of individual loan contracts, but rather are collected in the shape of the most frequent rates on certain loan and deposit categories.

1. Bank lending rates

To test for the pass-through differences across banks suggested by the preceding propositions, short-term and longer-term lending rates charged by German banks were selected. For short-term lending business, the Deutsche Bundesbank collects data, for instance, on current account credit rates, charged for new credit agreements or for their renewal. Current account credit, i.e. the cost of recourse to a short-term credit line by an enterprise, frequently represents standard loans to corporate customers. Rather than a fixed rate of interest, in these loan agreements a mark-up on the money market rate is usually offered to "blue-chip" customers, whereas a mark-up on an internal bank prime rate applies for other borrowers.[29] For long-term loans, interest rates on new business or renewals – thus not to the overall volume outstanding – are taken as derived from both five-year mortgage loans and longer-term corporate loans (loans to firms and self-employed persons) with an agreed interest rate lock-in period of more than five years.[30] The mortgage rate is investigated in this study for comparative purposes. For each of the aforementioned interest rate types, estimations are carried out to test for adjustment differences across banks. However, no clear conclusions will be drawn about differences in the pass-through across interest rate types and about differences across the corresponding credit markets.[31]

The rates on both short-term and long-term corporate loans are reported for various size categories. Until the end of 2001, the rates reported on current account credit were subdivided according to the credit 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".[32] 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.

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29 The bank often reserves the right to adjust the agreed mark-up in the event of changes in the borrower's credit standing.

30 See the guidelines for the interest rate statistics of the Deutsche Bundesbank, June 2000. With regard to the mortgage rate, the effective interest rate is collected. An annual basic redemption of 1% plus interest saved is presupposed.

31 It may be supposed that the response of individual interest rates differs since competition among banks and the competition with market terms have presumably developed divergently in different credit markets. Moreover, the collateralisation of loans might affect the adjustment process of lending rates. In that case, the interest rate response depends on how closely such collateral is valued to market conditions.

32 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".

Table 1: Distribution of reported bank lending rates

Reported lending rate	Rate on large current account credit*	Rate on small current account credit*	Rate on large long-term corporate loans**	Rate on small long-term corporate loans**	Rate on five-year mortgage loans*
and at the same time:					
Rate on large current-account credit*	**239** **(13601)**	213 (11894)	130 (5027)	146 (5505)	184 (9626)
Rate on small current-account credit*		**398** **(26035)**	169 (6105)	232 (7960)	307 (18752)
Rate on large long-term corporate loans**			**181** **(7427)**	176 (7281)	170 (6606)
Rate on small long-term corporate loans**				**244** **(10171)**	226 (8982)
Rate on five-year mortgage loans*					**364** **(24111)**
	Number of time series in the panel, in parenthesis: number of reported interest rates				
	The number of time series exceeds the number of banks in the panel because the time series were split in cases of mergers, takeovers or incomplete time series.				
	**) April 1993 to December 2000, **) November 1996 to December 2000*				

In each loan category and size category the reported interest rate is 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. Altogether, 492 bank time series with consecutive interest rate reports are analysed. Some of the time series are split because the time series are incomplete or because mergers or takeovers took place. Hence the number of time series exceeds the number of interest rate reporting banks. In the period under review, not all banks reported rates on all the loan categories described above. Table 1 shows the corresponding intersections of sets of the interest rate reports. The average length of the time series for five-year mortgage rates is 66 months for current account credit rates, 57 months (for credit of DM1 million and over but less than DM5 million) and 65 months (for credit of less than DM1 million), and, for the long-term corporate loans collected from November 1996, 41 months.

2. Selection of market interest rates

The present paper examines the response of the lending rates charged by banks for new contracts or for loan renewals to movements in market rates. Since the interest rate data are available on a monthly basis, average monthly market rates are likewise used. The criterion on which the market rates are selected is a comparable maturity. For short-term current account

credit rates, which are dependent on the money market, and may therefore be varied daily, until June 1996 the Frankfurt overnight rate, until December 1998 FIONA terms, and since January 1999 EONIA terms are used as reference rates. For interest rates on long-term corporate loans, the yield on German fixed-rate bearer debt securities outstanding is chosen as a reference rate. The yield on German bearer debt securities outstanding with a mean residual maturity of more than four up to five years is selected as a reference rate on mortgage rates locked in for five years.

3. Mergers and takeovers

Altogether, in the period under consideration from April 1993 to December 2000, over 200 mergers and takeovers took place among the interest rate reporting banks which existed after the takeover or merger. Since mergers and takeovers may well lead to a change in lending rate policy or, due to changed customer patterns, to a different level of lending rates, takeovers should not be neglected in principle. If the original interest rate time series of the bank affected by a merger or takeover is left as it is, in the model with fixed effects, a bank-specific level effect is estimated that disregards a possible jump in the data. For that reason, takeovers and mergers were taken into account in such a way that an interest rate time series A bank is split into time series A_1 up to the moment of takeover or merger and time series A_2 after the takeover or merger.[33] The time series B of the bank taken over definitely ends at the moment of takeover. In order to ensure sufficient asymptotics in the context of the error correction estimation, an attempt was made not to shorten the time series unduly; the interest rate time series were split only in those cases in which the balance sheet total of the respective bank increased by more than 10% at the moment of takeover or merger. In all other cases, the original time series remains unchanged.

4. Aggregate time series

Figure 2 shows that the mark-up between average current account credit rates[34] and the overnight rate widened during the period of falling money market rates. During the low interest rate period since 1996, the mark-up has narrowed again, but it widened once more in the course of 1999. The rises since then in the money market rate have resulted yet again in

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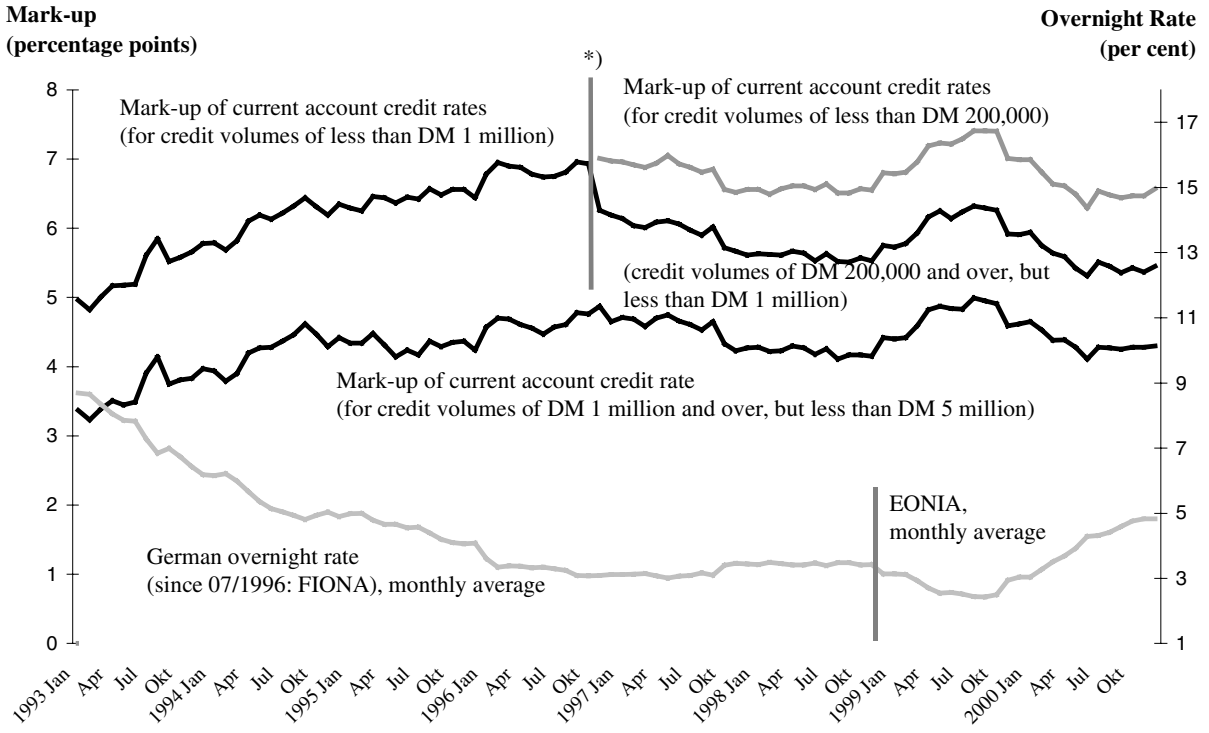
33 An alternative way of treating mergers and takeovers would be to recompute the lending rate and balance sheet data of the banks concerned in the period prior to the takeover or merger. See, for instance, Ehrmann and Worms (2001). However, I refrain from adopting this approach in view of the problems posed by determining a correct fictitious lending rate.

34 Aggregate bank lending rates of the Deutsche Bundesbank are unweighted arithmetical means of the monthly bank reports after eliminating the largest and smallest 5% of all reports in a given month.

Figure 1: Overnight interest rate and mark-up of current account credit rates



*) November 1996: changeover in the bank interest rate statistics

Figure 2: Yield on German bearer debt securities outstanding and mark-up of long-term corporate lending rates

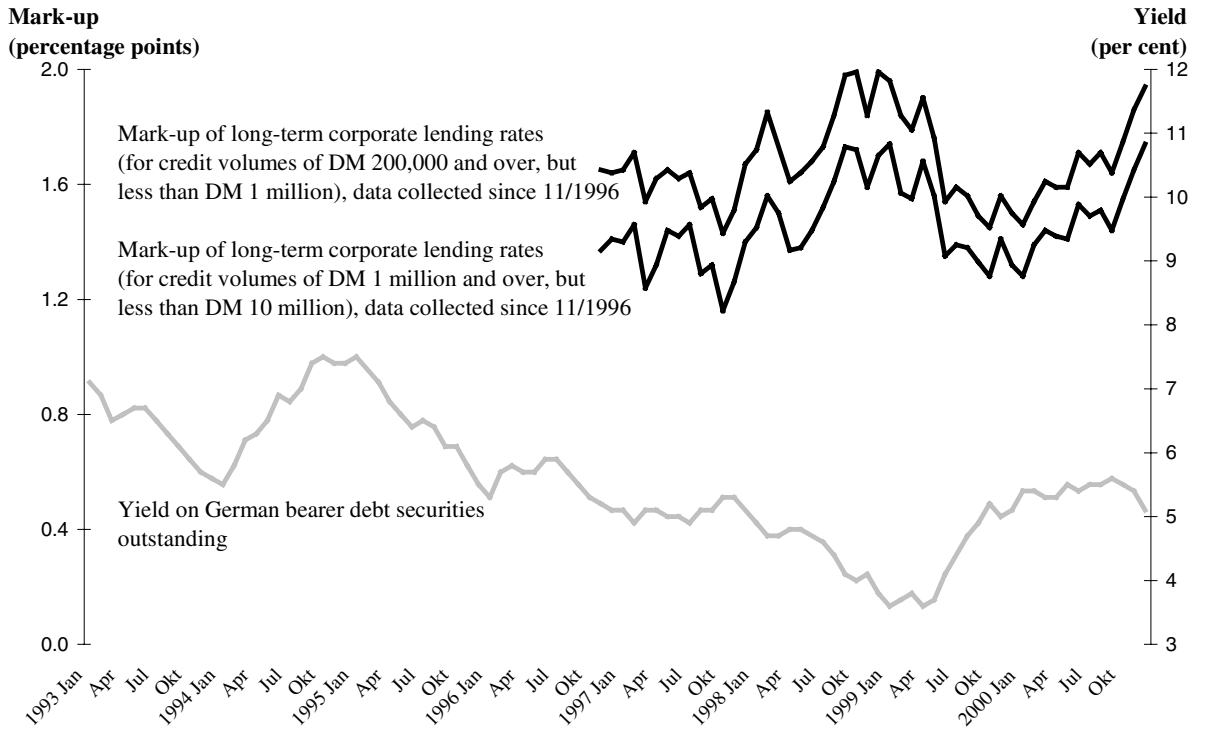
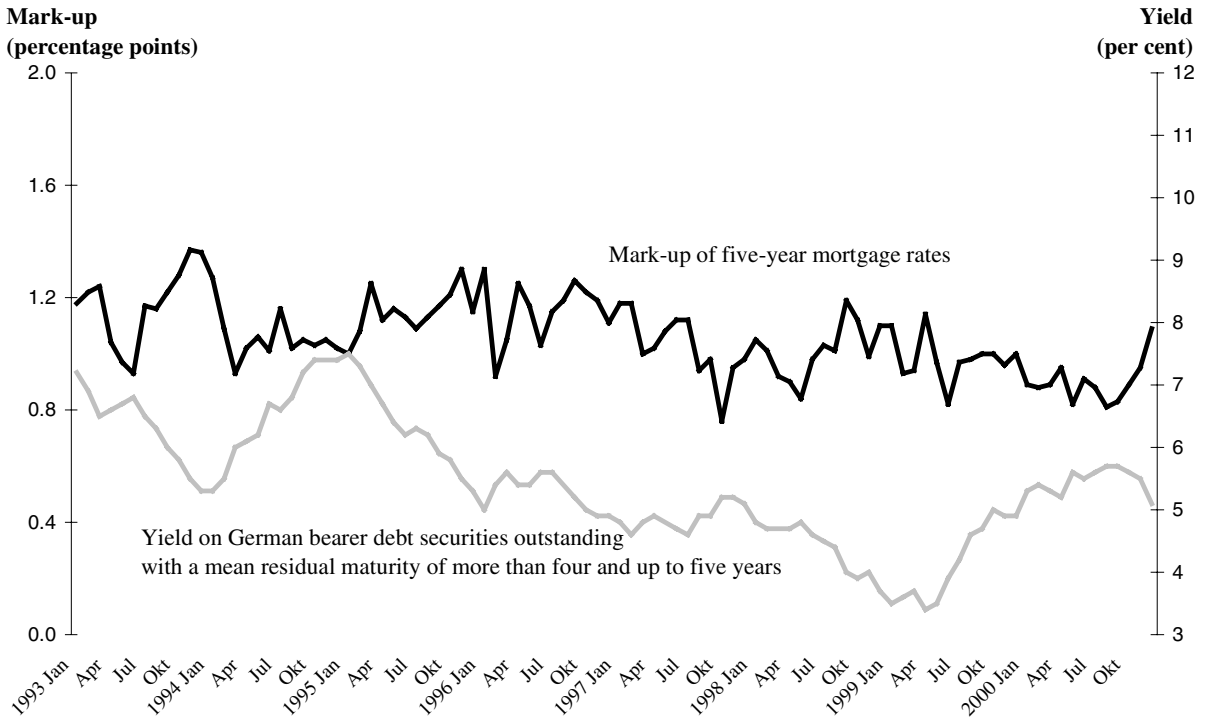


Figure 3: Yield on German bearer debt securities outstanding and mark-up of five-year mortgage rates



declining mark-ups. This suggests an anticyclical movement of mark-ups. On the changeover of the interest rate statistics of small current account credits in November 1996, the mark-up of contracts in the credit category between DM200,000 and less than DM1 million underwent a downward leap, whereas that on contracts in the credit category below DM200,000 remained at a high level. Since the changeover in the bank interest rate statistics, the mark-up of the rate on large credit (between DM1 million and less than DM5 million), at 4 to 5 percentage points, is about 1½ points below that of the rate on small credit (between DM200,000 and less than DM1 million). Apart from that, the mark-ups of both current account credit rates were almost consistently in the same direction, and since 1997 have been nearly parallel. However, a complete interest rate cycle is not available for short-term corporate lending.

Overall, the period under review is marked by declining money market rates. It is only since the end of 1999 that they have started to move upwards again. Figure 2 indicates that the mark-up between five-year mortgage rates and the yield on more than four up to five-year German bearer debt securities outstanding fluctuated during the 1990s between 0.7 percentage points and 1.4 points. Despite a generally decreasing yield on five-year bonds outstanding, the mortgage rate mark-up has not widened.

Table 2: Distribution of balance-sheet indicators across banks

Percentile	Balance sheet total (bn euro)	Savings deposits / liabilities	Long-term business with non-banks*	Refinancing indicator of long-term non-bank loans**
Interest rate reporting banks				
10	0.21	0.00	0.47	0.00
20	0.36	0.15	0.65	0.03
30	0.55	0.25	0.75	0.05
40	0.81	0.30	0.83	0.10
50	1.26	0.33	0.89	0.14
60	1.84	0.35	0.93	0.18
70	2.70	0.38	0.96	0.23
80	4.30	0.40	1.00	0.29
90	13.53	0.43	1.04	0.41
All banks* **				
10	0.02	0.21	0.61	0.00
20	0.04	0.28	0.75	0.00
30	0.06	0.32	0.85	0.02
40	0.08	0.35	0.90	0.04
50	0.11	0.37	0.94	0.07
60	0.16	0.39	0.98	0.11
70	0.25	0.41	1.01	0.15
80	0.46	0.44	1.04	0.20
90	1.07	0.48	1.09	0.27
	Percentile value of average balance sheet indicators (Apr. 1993 to Dec. 2000)			

*) Long-term non-bank credit and corresponding non-bank deposits, relative to the balance sheet total

**) Difference between long-term non-bank credit and corresponding non-bank deposits, relative to total loans to non-banks

***) German banking sector (interest rate reporting banks and other banks)

Table 3: Classification of interest rate reporting banks

	Balance sheet total (bn euro)	Savings deposits / liabilities	Long-term business with non-banks*	Refinancing indicator of long-term non-bank loans**
Bank category 1	> euro 2.7 bn	> 0.37	> 0.94	> 0.20
Bank category 2	between euro 0.5 bn and euro 2.7 bn	between 0.28 and 0.37	between 0.75 and 0.94	between 0.07 and 0.20
Bank category 3	<= euro 0.5 bn	<= 0.28	<= 0.75	<= 0.07
	Boundaries of bank categories			

*) Long-term non-bank credit and corresponding non-bank deposits, relative to the balance sheet total

**) Difference between long-term non-bank credit and corresponding non-bank deposits, relative to total loans to non-banks

The mark-up between the interest rates on long-term corporate loans and the yield on German bonds outstanding was around one to two percentage points in the years 1997 to 2000, and has moved anticyclically to the yield on bearer debt securities outstanding (Figure 3). The mark-ups of the credit amounts above and below DM1 million have moved for the most part along similar lines. During the period of declining bond yields between autumn 1997 and spring 1999, the mark-ups widened from 1.4 percentage points and 1.2 percentage points, to 2.0 percentage points and 1.7 points, respectively. As yields subsequently went up, the interest rate differential narrowed again. The decline and rise in bond yields since 1997 have been just about equally strong. To sum up, the average monthly yield on German bearer debt securities outstanding varies distinctly more than the average monthly overnight rate. Thus, in the case of long-term interest rates, the rise and fall of interest rates are distributed more evenly than in the case of short-term rates.

4. Bank classification

Table 2 shows the distributions of the bank-specific balance sheet indicators under investigation. The table shows that the percentile values of the interest rate reporting banks do not exactly conform to those which apply to the German banking sector as a whole. In particular, the German banking sector, as far as the number of institutions is concerned, is dominated by savings banks and cooperative banks even more strongly than in the panel of interest rate reporting institutions.[35] With regard to the balance sheet characteristics under review, larger banks, institutions with few savings deposits and banks with a small amount of long-term non-bank business are over-represented in the panel. The interest rate reporting banks are divided into three categories of similar number for each balance sheet indicator and each interest rate under review.[36] The classifications in Table 3 are used for all pass-through estimations carried out in this study.

V. Econometric results

Error correction estimations were carried out for each balance sheet indicator in five lending rates.[37] The model was specified with two lags for long-term corporate lending rates, and with

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35 See Table A.1 in Annex A.

36 The banks were classified such that each bank category represents a roughly similar number of banks for each type of interest rate, although the number of reporting banks differs from one type of interest rate to another (see Table 1).

37 The balance sheet indicators under review were not tested for independence. Although correlation between these indicators could not be ruled out, all estimations were carried out for each indicator separately.

three lags for the remaining lending rates.[38] Table 4 shows the one-month pass-through elasticities, the loading coefficients and the long-run relationships computed from the estimation coefficients of the error correction model for the upper bank category of each indicator and the lower bank category of each indicator. All of these have the expected sign and are significant.[39]

In the panel error correction regressions, the r-squared (within-estimations) range between 16% and 20% in the estimations of current account credit rates, between 30% and 34% in the estimations of long-term corporate lending rates and about 54% in the five-year mortgage rate estimates. The estimations suggest certain deviations in the pass-through across interest rate types. Whereas the loading coefficient of current account credit rates ranges between –0.05 and –0.18, the figures for long-term corporate lending rates vary between –0.09 and –0.24. The corresponding one-month pass-through varies between 36% and 58% for current account credit rates. For long-term corporate lending rates, the corresponding pass-through values are 52% up to 91%. The mortgage rates under review seem to be even less sticky than corporate lending rates. Figure 4 indicates that mortgage rates adjust almost completely to changing yields on bonds outstanding after only a few months. Their loading coefficients vary between –0.20 and –0.31, and values between 78% and 91% are recorded for the one-month pass-through. One reason for these strong short-term responses might be mortgage loan collateralisation, which reduces the problems of information asymmetries faced by the bank. This result corresponds to the stability of the mortgage rate mark-up which is found in Figure 3. Second, the short run relationship between current account credit rates and overnight interest rates is looser than the relationship between long-term corporate lending rates and the yield on bonds outstanding. Third, in the case of both short-term and long-term corporate lending rates, the interest rates on large credit adjust faster than the corresponding interest rates on less than DM1 million. Thus loan size plays a role. But given the differences in the estimation periods, interest rate cycles and in the number of reporting banks (Table 1), these findings must be interpreted cautiously. The impulse-response functions in Figure 4 show the responses in the first 12 months after a simulated change in the market rate by 100 basis points. The graphs show a differential reaction across bank categories which seems to be more accentuated among corporate lending rates than in the mortgage rate case. Pass-through differences become especially apparent in the rates charged for current account credit.

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38 The lag length was chosen such that all significant lags of the exogenous and endogenous variables are included in the model. The estimation residuals are serially uncorrelated, which has been tested for first order autocorrelation. A common feature of all estimations is that the change in lending rates depends positively on the contemporary and the lagged changes in market interest rates.

39 Estimations with heteroscedasticity consistent standard errors. With respect to the adjustment process, the significance of the coefficient γ, part of the loading coefficient, is important: γ consistently has a significantly negative sign. This is crucial, given the assumption of a long-run relationship between the lending and the market rate.

Table 4: Estimation results. One-month pass-through elasticities, loading coefficients and long-run relationships: Testing for equality across banks

Pass-through elasticities (x), loading coefficients (g), long-run relationships (b) and its standard errors are functions of the error correction estimates and its variance-covariance matrix. Test of the null hypotheses: H_0: x_1-x_3 = 0, H_0: g_1-g_3 = 0 and H_0: b_1-b_3 = 0. Standard errors (in parenthesis) are calculated using the delta method. Equality is rejected with significance at 10% level (*), 5% level (**), 1% level (***).

Bank classification and interest rate type	One-month pass-through elasticity			Loading coefficient			Long-run relationship between the market and the lending rate		
	Bank category 1 (x_1)	Bank category 3 (x_3)	Difference x_1 - x_3	Bank category 1 (g_1)	Bank category 3 (g_3)	Difference $\|g_1\|$ - $\|g_3\|$	Bank category 1 ($-b_1$)	Bank category 3 ($-b_3$)	Difference $\|b_1\|$ - $\|b_3\|$
Bank size	Category 1: Total bank assets > 2.7 bn Euro, Category 3: Total bank assets <= 0.5 bn Euro								
expected sign:	+	+	+	-	-	+	-	-	+/-
Current account credit rate, large [1]	0.516 (0.045)	0.448 (0.054)	**0.068** (0.070)	-0.177 (0.027)	-0.105 (0.016)	**0.073** ** (0.031)	-0.694 (0.041)	-0.701 (0.076)	**-0.008** (0.086)
Current account credit rate, small [2]	0.450 (0.035)	0.356 (0.024)	**0.094** ** (0.043)	-0.126 (0.014)	-0.084 (0.010)	**0.042** ** (0.018)	-0.727 (0.038)	-0.665 (0.051)	**0.062** (0.064)
Long-term corporate lending rate, large [3]	0.914 (0.035)	0.599 (0.055)	**0.315** *** (0.064)	-0.238 (0.035)	-0.090 (0.016)	**0.148** *** (0.038)	-0.990 (0.033)	-1.078 (0.104)	**-0.087** (0.109)
Long-term corporate lending rate, small [4]	0.876 (0.037)	0.520 (0.049)	**0.356** *** (0.062)	-0.194 (0.033)	-0.127 (0.017)	**0.067** * (0.037)	-0.989 (0.041)	-0.892 (0.066)	**0.096** (0.078)
Mortgage rate [5]	0.907 (0.011)	0.782 (0.020)	**0.125** *** (0.023)	-0.221 (0.021)	-0.245 (0.029)	**-0.023** (0.023)	-0.912 (0.014)	-0.894 (0.014)	**0.018** (0.019)
Refinancing indicator of long-term non-bank loans	Category 1: (Long-term non-bank loans - long-term non-bank deposits) > 20% (Category 3: <= 7%) of total non-bank loans								
expected sign:	+	+	+	-	-	+	-	-	+/-
Current account credit rate, large [1]	0.563 (0.046)	0.454 (0.040)	**0.109** * (0.061)	-0.140 (0.020)	-0.118 (0.016)	**0.022** (0.020)	-0.752 (0.045)	-0.620 (0.053)	**0.132** * (0.069)
Current account credit rate, small [2]	0.453 (0.032)	0.397 (0.024)	**0.056** (0.040)	-0.104 (0.012)	-0.081 (0.012)	**0.023** (0.015)	-0.779 (0.049)	-0.722 (0.054)	**0.058** (0.074)
Long-term corporate lending rate, large [3]	0.829 (0.041)	0.724 (0.054)	**0.105** (0.066)	-0.167 (0.043)	-0.106 (0.018)	**0.060** (0.047)	-0.945 (0.057)	-0.961 (0.069)	**-0.016** (0.089)
Long-term corporate lending rate, small [4]	0.831 (0.039)	0.691 (0.047)	**0.140** ** (0.060)	-0.145 (0.036)	-0.131 (0.018)	**0.014** (0.040)	-0.951 (0.051)	-0.981 (0.057)	**-0.031** (0.077)
Mortgage rate [5]	0.909 (0.012)	0.797 (0.018)	**0.112** *** (0.022)	-0.256 (0.020)	-0.209 (0.022)	**0.047** (0.030)	-0.927 (0.011)	-0.930 (0.014)	**-0.003** (0.018)
Savings deposits	Category 1: Savings deposits > 37% of total liabilities, Category 3: Savings deposits <= 28% of total liabilities								
expected sign:	+	+	-	-	-	-	-	-	+/-
Current account credit rate, large [1]	0.441 (0.047)	0.579 (0.041)	**-0.137** ** (0.062)	-0.095 (0.019)	-0.159 (0.021)	**-0.065** ** (0.028)	-0.557 (0.077)	-0.744 (0.037)	**-0.187** ** (0.085)
Current account credit rate, small [2]	0.367 (0.022)	0.481 (0.040)	**-0.114** ** (0.046)	-0.055 (0.009)	-0.130 (0.017)	**-0.075** *** (0.019)	-0.742 (0.067)	-0.735 (0.042)	**0.008** (0.079)
Long-term corporate lending rate, large [3]	0.763 (0.054)	0.811 (0.046)	**-0.049** (0.071)	-0.099 (0.016)	-0.231 (0.036)	**-0.132** *** (0.039)	-1.039 (0.070)	-0.953 (0.044)	**0.086** (0.083)
Long-term corporate lending rate, small [4]	0.745 (0.047)	0.772 (0.048)	**-0.026** (0.067)	-0.122 (0.018)	-0.202 (0.029)	**-0.081** ** (0.034)	-1.022 (0.063)	-0.951 (0.046)	**0.071** (0.078)
Mortgage rate [5]	0.811 (0.017)	0.875 (0.015)	**-0.064** *** (0.022)	-0.204 (0.022)	-0.276 (0.021)	**-0.071** ** (0.030)	-0.908 (0.014)	-0.915 (0.012)	**-0.007** (0.019)
Long-term business with non-banks	Category 1: (Long-term non-bank loans + long-term non-bank deposits) > 94% (Category 3: <= 75%) of balance sheet total								
expected sign:	+	+	-	-	-	-	-	-	+/-
Current account credit rate, large [1]	0.435 (0.038)	0.576 (0.042)	**-0.141** ** (0.057)	-0.097 (0.021)	-0.146 (0.020)	**-0.049** * (0.029)	-0.692 (0.075)	-0.730 (0.042)	**-0.038** (0.086)
Current account credit rate, small [2]	0.380 (0.021)	0.499 (0.046)	**-0.119** ** (0.050)	-0.063 (0.009)	-0.145 (0.019)	**-0.082** *** (0.021)	-0.774 (0.057)	-0.714 (0.044)	**0.060** (0.073)
Long-term corporate lending rate, large [3]	0.823 (0.047)	0.794 (0.052)	**0.029** (0.070)	-0.105 (0.016)	-0.212 (0.044)	**-0.107** ** (0.047)	-1.036 (0.073)	-0.975 (0.047)	**0.061** (0.086)
Long-term corporate lending rate, small [4]	0.792 (0.043)	0.747 (0.054)	**0.046** (0.068)	-0.122 (0.016)	-0.193 (0.035)	**-0.071** * (0.039)	-1.005 (0.063)	-0.949 (0.046)	**0.056** (0.078)
Mortgage rate [5]	0.846 (0.014)	0.808 (0.022)	**0.038** (0.026)	-0.202 (0.022)	-0.307 (0.027)	**-0.105** *** (0.035)	-0.814 (0.016)	-0.864 (0.014)	**-0.049** ** (0.022)

[1]) Credit volumes between DM 1 million and less than DM 5 million
[2]) Credit volumes less than DM 1 million, since November 1996: credit volumes between DM 200,000 and less than DM 1 million
[3]) Rate on corporate loans to firms and self-employed for volumes between DM 1 million and less than DM 10 million, agreed maturity of more than 5 years
[4]) Rate on corporate loans to firms and self-employed for volumes between DM 200,000 and less than DM 1 million, agreed maturity of more than 5 years
[5]) Rate on mortage loans with an agreed maturity of 5 years

Table 4 (cont.)

Model specification for the five-year mortgage rate and the current account credit rates:

$$\Delta r_{i,t} = \sum_{k=1}^{3} \varphi_k \Delta r_{i,t-k} + \sum_{q=0}^{3} \omega_q \Delta m_{t-q} + g\,[r_{i,\,t-1} - b\,m_{t-1} - c_i] + \varepsilon_{i,t}$$

Model specification for the long-term corporate lending rates:

$$\Delta r_{i,t} = \sum_{k=1}^{2} \varphi_k \Delta r_{i,t-k} + \sum_{q=0}^{2} \omega_q \Delta m_{t-q} + g\,[r_{i,\,t-1} - b\,m_{t-1} - c_i] + \varepsilon_{i,t}$$

Loading coefficient: g

Long-run relationship: b from $r_i = bm + c_i = 0$ where r_i = lending rate, m = market rate and c_i = constant of bank i

1-month pass-through elasticity: $x = \varphi_1\omega_0 + \omega_1 + g\omega_0 - gb + \omega_0$ on the assumptions: $\Delta m_{t-1} = m_{t-1} = 1$ and $\Delta r_{t-1} = r_{i,\,t-1} = \omega_0$

Table 4 presents the results of the tests for equality between pass-through elasticities, loading coefficients and long-run relationships, respectively, relative to the balance sheet indicators under review. The differences in the adjustment process across banks have the expected sign in almost every case.[40] The one-month pass-through difference (upper versus lower bank category) is significant for most lending rates, i.e. its equality is rejected. Relating to the bank size and to the refinancing conditions of long-term loans to non-banks, the expected adjustment paths are reflected most clearly.[41] In the case of savings deposits and the long-term business with non-banks, the differences in current account credit rates are particularly marked. But in the case of the other interest rates analysed, too, the pass-through elasticities differ according to the propositions. Besides these differences, the loading coefficients are significantly different in nearly all of the classifications by size, by savings deposits and by long-term non-bank business. An exception is the refinancing indicator of long-term loans to non-banks. Here the estimations suggest equality in the loading coefficients. Apparently differentials turn out in the very short-run.[42]

As expected, differences in the long-run relationship between lending and market rates are insignificant in most of the estimations. Thus for the most part, all banks reach a comparable long-run relationship. A conspicuous feature is that, in the case of current account credit rates,

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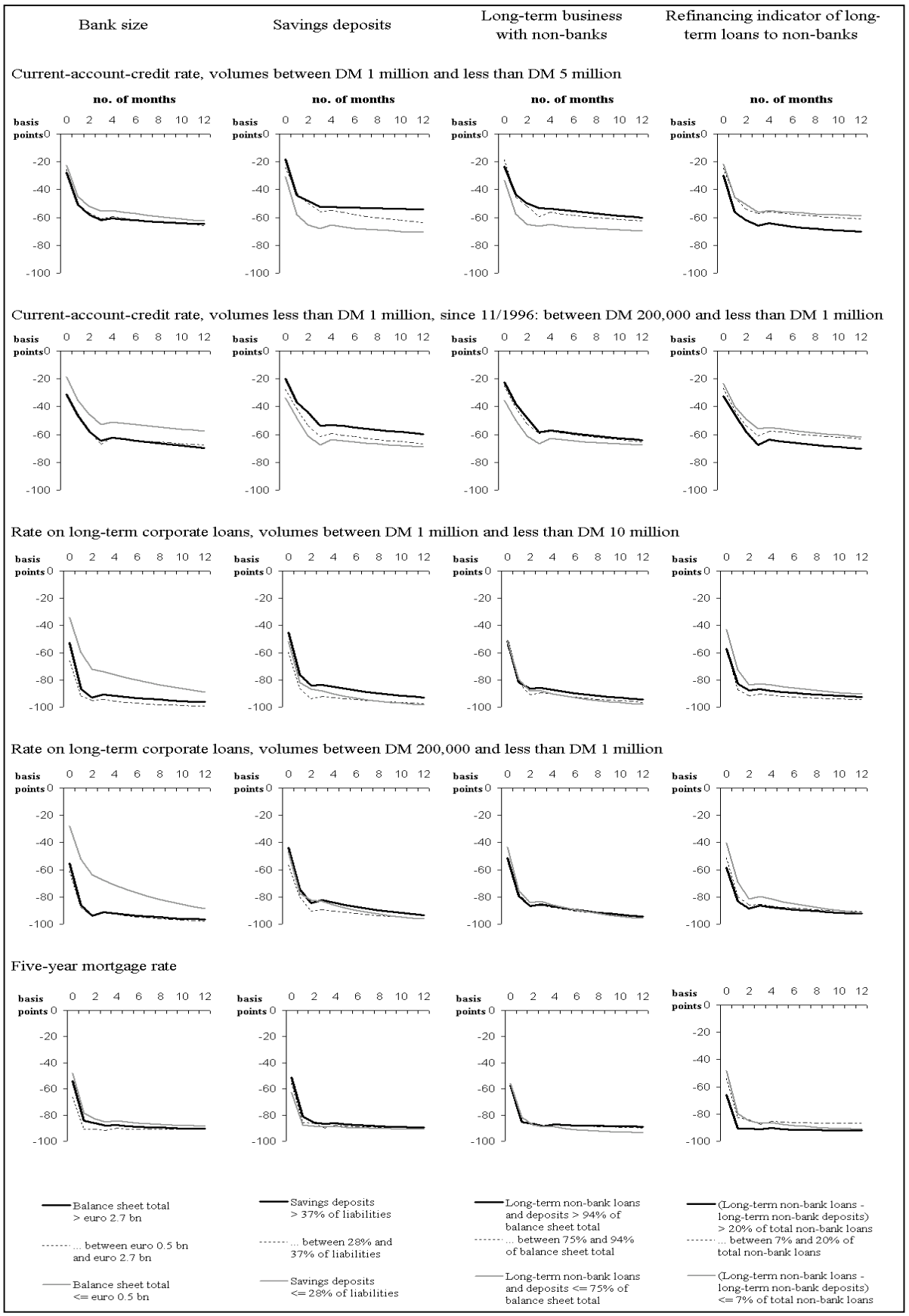
40 The criterion of long-term non-bank business forms an exception. Whereas current account credit rates exhibit the expected differences, such differences are not borne out in the case of the five-year mortgage rate and of the interest rates on long-term lending to firms. On this point, see also Figure 4.

41 See Figure 4.

42 As measured by the pass-through elasticity, in the case of three to five interest rates, banks with an unstable refinancing of long-term non-bank loans respond significantly faster than banks with more stable refinancing, as measured by the extent of corresponding non-bank deposits.

Figure 4: Lending rate response to a simulated change in the market rate

Response of the bank lending rate (change in basis points from initial level) to a 100 basis point decrease in the respective market rate



the long-run relationships are comparatively weak, i.e. about 70 per cent of a move in the money market rate. This may owe something to the incomplete interest rate cycle in the money market during the period of the estimation, with its marked decline in money market rates. By contrast, in the case of long-term interest rates, where interest rate rises and falls tended to cancel out during the period of the estimation, there is much evidence that all banks reporting interest rates, regardless of their adjustment process and regardless of balance sheet characteristics, achieve values much closer to one.[43] That applies especially to long-term corporate lending rates, for which an almost complete long-run relationship (about 1:1) is borne out: the coefficient δ of the level term outside the error correction expression is insignificant in the estimations for these interest rates.[44] With regard to the five-year mortgage rates and the current account credit rates, δ is significant. Hence, during the period 1993 to 2000, market rates are only partially passed on to these rates.

VI. Summary and conclusion

The focus of this study was to examine structural differences in the response across German banks in the 1990s. The empirical tests were based on lending rates in different credit types. With respect to the coincidence of the pass-through with the balance sheet characteristics investigated, the empirical results suggest the following:

1. *Larger credit institutions adjust their lending rates to changes in market rates faster than smaller credit institutions.*

   An explanation of this finding might be that smaller credit institutions, on the assumption that their customers are more dependent on bank credits, compete less intensely with market terms and adjust their lending rates comparatively slowly. Moreover, as large banks have better access to the capital market than small banks, large banks may offset deposit changes, in the event of a monetary policy change, by flexible borrowing on market terms, which has a comparatively rapid effect on their lending rates.

2. *Those banks that are refinanced to a major extent by savings deposits adjust their lending rates to changes in market rates comparatively slowly.*

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43 Particularly in the case of long-term corporate lending rates, interest rate upturns and downturns are roughly equally represented, notwithstanding the shorter estimation period (end-1996 to end-2000).

44 Thus the long-run interest rate relationship $\gamma/(\gamma+\delta)$ equals 1. See chapter III.

Sizeable savings deposits, relative to their liabilities, constitute a stable base for refinancing, despite increasingly differentiated interest rates during the period under review. By contrast, interest rate reporting banks with few savings deposits align their lending rates more closely to market rates.

3. *In the short run, the lending rates of those banks that have to refinance their long-term lending to non-banks on market-related terms respond more strongly to changes in market rates than those of banks that cover their long-term non-banks loans by corresponding non-bank deposits.*

   As regards the effect of long-term non-bank deposits on the stickiness of lending rates, the maturity of the loans accompanying such deposits is relevant in the short run. Long-term non-bank deposits which represent a large share of a bank's long-term lending enable the bank to set its lending rates more independently in the first months after a market rate change.

4. *The lending rates of those banks with large volumes of long-term business with households and companies are stickier than those of banks where this business plays only a limited role.*

   If a bank is heavily involved in lending and deposit business with non-banks, it has greater scope for smoothing interest rates. A possible interpretation could be that a great amount of business with non-banks is evidence of a major role played by relationship banking.

One objective of this study is to help explain the pass-through from money market and capital market rates to selected lending rates of German banks. For this reason, the relationship between balance sheet characteristics of German banks and their interest rate response during the 1990s was examined. In most of the estimations, the expected differences in the adjustment behaviour have been borne out. On the other hand, the estimation results suggest, for the most part, that the heterogeneity across German interest rate reporting banks does not affect the long-run relationship between lending and market rates. In this study, the balance sheet indicators under review were not tested for independence. Although a correlation between these indicators cannot be ruled out, estimations for each indicator were carried out separately. The question as to the implications of the further integration of the financial markets and of the pressure towards consolidation in the banking sector remains open. Even if competition in the banking sector warrants expectations of a faster interest rate pass-through, the findings of the study provide no answer to the question of whether that is what actually occurs.

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Annex A: Characteristics of interest rate reporting banks

A.1: Interest rate reporting banks in Germany by sector

	Number of monetary financial institutions		Number of reports*	Share in total assets of all institutions
Savings banks and Cooperative banks	255	73%	257	10%
Other banks	93	27%	215	51%
Total	**348**	**100%**	**472**	**61%**

*) Reports from branches of larger banks are counted separately.

Source: Deutsche Bundesbank, data of August 2000

A.2: Average balance sheet composition, all banks vs. interest rate reporting banks

	Assets of all banks			Assets of interest rate reporting banks		
per cent of balance sheet total	other banks	savings banks	cooperative banks	other banks	savings banks	cooperative banks
December 1992						
book claims to banks	32%	12%	16%	26%	12%	14%
book claims to non-banks	46%	53%	56%	54%	53%	62%
fixed-income securities	15%	21%	18%	11%	20%	15%
other assets	7%	14%	9%	9%	15%	9%
	100%	100%	100%	100%	100%	100%
December 2000						
book claims to banks	31%	7%	12%	24%	8%	12%
book claims to non-banks	48%	60%	63%	50%	56%	63%
fixed-income securities	16%	20%	17%	14%	22%	15%
other assets	5%	13%	8%	11%	14%	10%
	100%	100%	100%	100%	100%	100%

	Liabilities of all banks			Liabilities of interest rate reporting banks		
per cent of balance sheet total	other banks	savings banks	cooperative banks	other banks	savings banks	cooperative banks
December 1992						
liabilities to banks	41%	13%	8%	34%	12%	9%
liabilities to non-banks	36%	75%	82%	45%	73%	74%
of which savings deposits	10%	34%	31%	8%	33%	27%
securitized liabilities	6%	5%	4%	9%	7%	11%
other	16%	7%	6%	12%	7%	6%
	100%	100%	100%	100%	100%	100%
December 2000						
liabilities to banks	39%	24%	15%	31%	23%	15%
liabilities to non-banks	43%	62%	72%	45%	62%	64%
of which savings deposits	10%	34%	37%	8%	33%	31%
securitized liabilities	11%	4%	8%	11%	5%	14%
other	8%	10%	6%	13%	10%	7%
	100%	100%	100%	100%	100%	100%

Source: Deutsche Bundesbank

A.3: Distribution of bank time series by bank category

The number of time series (492) exceeds the number of banks in the sample, because time series were split in the case of mergers, takeovers and incomplete time series.

Bank size (balance sheet total)	Refinancing indicator of long-term non-bank loans* <=7%	between 7% and 20%	>20%	All reporting banks in the category
<= euro 0.5 bn	14%	12%	6%	**32%**
between euro 0.5 bn and euro 2.7 bn	14%	14%	10%	**38%**
> euro 2.7 bn	5%	9%	16%	**30%**
All size categories	**33%**	**36%**	**32%**	**492 time series**

Bank size (balance sheet total)	Savings deposits - liability ratio <=28%	between 28% and 37%	>37%	All reporting banks in the category
<= euro 0.5 bn	8%	13%	11%	**32%**
between euro 0.5 bn and euro 2.7 bn	12%	13%	13%	**38%**
> euro 2.7 bn	18%	8%	4%	**30%**
All size categories	**38%**	**34%**	**28%**	**492 time series**

Bank size (balance sheet total)	Long-term business with non-banks** <=75%	between 75% and 94%	>94%	All reporting banks in the category
<= euro 0.5 bn	8%	12%	13%	**32%**
between euro 0.5 bn and euro 2.7 bn	11%	14%	13%	**38%**
> euro 2.7 bn	14%	10%	6%	**30%**
All size categories	**33%**	**36%**	**31%**	**492 time series**

*) [long-term non-bank loans - corresponding non-bank deposits] / total non-bank loans
**) [long-term non-bank credit + corresponding non-bank deposits] / balance sheet total

A.4: Representation of interest rate reporting banks belonging to a banking federation

Bank size (balance sheet total), category:	Banks not belonging to a banking federation	Banks belonging to a banking federation*	*... as a share of all reporting banks in the category*	All reporting banks in the category
<=0.5 bn Euro	5%	27%	*84%*	**32%**
other	7%	31%	*82%*	**38%**
>2.7 bn Euro	11%	19%	*65%*	**30%**
All categories	**23%**	**77%**		**492 time series**

Refinancing of long-term loans to non-banks, category:	Banks not belonging to a banking federation	Banks belonging to a banking federation*	*... as a share of all reporting banks in the category*	All reporting banks in the category
<=7%	2%	31%	*94%*	**33%**
other	8%	28%	*78%*	**36%**
>20%	13%	18%	*59%*	**32%**
All categories	**23%**	**77%**		**492 time series**

Savings deposits / liabilities, category:	Banks not belonging to a banking federation	Banks belonging to a banking federation*	*... as a share of all reporting banks in the category*	All reporting banks in the category
<=28%	20%	19%	*49%*	**38%**
other	3%	31%	*92%*	**34%**
>37%	0%	27%	*99%*	**28%**
All categories	**23%**	**77%**		**492 time series**

Long-term business with non-banks, category:	Banks not belonging to a banking federation	Banks belonging to a banking federation*	*... as a share of all reporting banks in the category*	All reporting banks in the category
<=75%	18%	15%	*45%*	**33%**
other	2%	34%	*94%*	**36%**
>94%	2%	29%	*92%*	**31%**
All categories	**23%**	**77%**		**492 time series**

*) savings banks and cooperative banks

Source: Deutsche Bundesbank

Annex B: Fixed-effects (within-) estimation

In panel econometrics, the within-estimation approach with fixed effects[45] is the following:

$$(B.1) \qquad Y_{i,t} = X_{i,t}' \beta + U_{i,t} \qquad \text{with } U_{i,t} = \mu_i + V_{i,t} \text{ and } V_{i,t} \sim \text{IID}(0,\sigma_V^2)$$

where $Y_{i,t}$ is the dependent variable and $X_{i,t}$ represents the explanatory exogenous variables. The residuals $U_{i,t}$ are composed of an individual effect μ_i and an uncorrelated error term $V_{i,t}$, following a standard distribution. The coefficient vector β, estimated jointly for all banks i, relies on the assumption that the lending rate setting does not differ across banks, except for μ_i. In a fixed-effects estimation, such bank-specific effects can be eliminated either by first differencing or by subtracting mean values. Least-square estimations, adjusted for mean values, are carried out in the present study.[46] For that purpose, the mean values of all the variables included in the estimation are subtracted from the respective values for every observation date. The mean subtraction in equation (B.4) is known as "within-transformation".[47] It results in all time-constant variables being suppressed. That means that the only model variables taken into account are those which change over time. In the process, the estimations become all the more precise, the more strongly the variables change over time.

$$(B.2) \qquad V_{i,t} = Y_{i,t} - \mu_i - X_{i,t}' \beta = Y_{i,t} - (\bar{Y}_i - \bar{X}_i' \beta - \bar{V}_i) - X_{i,t}' \beta$$

$$\text{where } \mu_i = \bar{Y}_i - \bar{X}_i' \beta - \bar{V}_i$$

$$\bar{Y}_i = \sum_{t=1}^{T} Y_{i,t} / T$$

$$\bar{X}_i = \sum_{t=1}^{T} X_{i,t} / T$$

$$\bar{V}_i = \sum_{t=1}^{T} V_{i,t} / T$$

$$V_{i,t} \sim \text{IID}(0, \sigma_v^2)$$

$$(B.3) \qquad V_{i,t} = (Y_{i,t} - \bar{Y}_i) - (X_{i,t} - \bar{X}_i)' \beta + \bar{V}_i$$

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45 See Baltagi (2001).

46 The least-square fixed-effects within-estimation is also named least-square dummy variable model. See Kiviet (1995).

47 Fixed time effects are disregarded here.

$$(B.4) \qquad Y_{i,t} - \bar{Y}_i = (X_{i,t} - \bar{X}_i)'\beta + V_{i,t} - \bar{V}_i$$

From (B.4), the coefficient vector β is estimated by b. The outcome for the individual effect is:

$$(B.5) \qquad \hat{\mu}_i = \bar{Y}_i - \bar{X}_i' b$$

Correspondingly, the following applies to panels with lagged endogenous variables $Y_{i,t-k}$:

$$(B.6) \qquad Y_{i,t} = \sum_{k=1}^{K} \alpha_k Y_{i,t-k} + X_{i,t}'\beta + \mu_i + V_{i,t}$$

$$(B.7) \qquad Y_{i,t} - \bar{Y}_i = \sum_{k=1}^{K} \alpha_k (Y_{i,t-k} - \bar{Y}_{i.-k}) + (X_{i,t} - \bar{X}_i)'\beta + V_{i,t} - \bar{V}_i$$

$$\text{where } \bar{Y}_{i.-k} = (T-k)^{-1} \sum_{t=k}^{T} Y_{i,t-k}$$

In dynamic fixed-effects within-estimations, the estimators are, however, biased upon the inclusion of lagged endogenous variables $Y_{i,t-k}$. Owing to the lagged dependent regressors, the error term $V_{i,t-k}$ is correlated with the endogenous variables $Y_{i,t-k.}$[48] Such correlation also leads to inconsistent estimators if the error terms $V_{i,t}$ in the within-estimation are uncorrelated.[49] The so-called Nickell bias is all the greater, the smaller the number of observation periods T is.[50] For instance, Kiviet (1995) shows that the within-estimator in dynamic models is inconsistent, both in the case of a small number of observations per period (i = 1...N) and in the case of few observation periods T. In that event, to prevent an estimation, instruments must be introduced for all endogenous regressors, which, although not correlated with the error terms, are strongly correlated with the explanatory variables.[51] On the basis of Kiviet (1995), Judson and Owen (1999), in their simulations, quantify the bias of the fixed-effects within-estimator for a varying number of observation periods, and prove that for T≥30 the estimator converges sufficiently towards the true value. The within-estimations carried out in the present study are based on this asymptotic behaviour, since up to 93 observation periods per bank are available in the panel-data set.

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48 See Sevestre and Trognon (1996) , pp. 125-130, and Baltagi (2001), p. 129 f.

49 See Baltagi (2001), p. 130.

50 Nickell (1981) derives an estimation bias for endogenous regressors, on the condition that no exogenous regressors exist. That bias tends towards zero as the number of periods T increases.

51 See Sevestre and Trognon (1996).

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