Monetary policy and investment behaviour – an empirical study

The effect of monetary policy measures on corporate investment decisions is generally regarded as a key element in the transmission process. Monetary policy affects investment decisions via the user cost of capital – a mechanism called the interest-rate channel. In addition, with imperfect capital markets, changes in a company's financial situation can affect its demand for fixed capital, bringing the "balance-sheet channel" into play.

In the present article, individual data for the German manufacturing sector from 1988 to 1997 are used to subject the interest-rate channel and balance-sheet channel to a thorough econometric investigation. The investigation shows that by European standards German investment behaviour is highly sensitive to the user cost of capital. However, the impact of interest-rate changes on the user cost of capital is only moderate. The empirical finding also confirms the existence of a balance-sheet channel. This channel, however, seems to be less important than the interest-rate channel. One important reason might lie in the significance of "house banking relationships", which are a unique feature of the German financial system.

Monetary transmission channels

Underlying monetary policy framework is decisive

The principal task of a central bank is to maintain price stability. The extent to which it performs this task successfully and the credibility of its efforts have long-run implications for the real economy, too. In this context, individual policy actions might be less important than the underlying monetary policy framework. If there is an absence of clarity regarding the strategy and objectives of monetary policy, inflation premia and risk premia will result, leading to higher real interest rates and deformed yield curves, which are deleterious to growth.[1] Conversely, the real interest-rate advantage the German economy had held in comparison to its European neighbours for many years may serve as a positive example.

Two stages of transmission

Over the short and medium run, monetary policy measures have additional real effects. They are links in complex transmission channels between the use of monetary policy instruments, on the one hand, and changes in factor and goods prices, on the other.[2] Analytically speaking, there are two distinct stages of monetary transmission. In the first stage, monetary policy measures impact on various segments of financial markets, which is reflected in adjustments of market rates and asset prices, exchange rates and other financial conditions (eg maturity structure). In a second stage, these changes alter domestic sectors' propensity to spend and are thus transmitted to the overall goods and incomes cycle. An especially important factor here is the way monetary policy measures influence corporate investment behaviour. Corporate investment is a very volatile component of aggregate demand, and its capacity and modernity effects make it an important factor in growth and employment. The following exposition will focus on this second stage of the monetary transmission process.[3]

The interest-rate channel

Starting point of the analysis

The theoretical starting point for analysing the interplay between the financial sector and a firm's factor demand is the fundamental separation theorem.[4] Its central tenet is that, with perfect capital markets, the value of a firm will always be independent of its financial structure, which means the decisions on factor demand and financing may be separated. Hence factor demand depends exclusively on "real" factors such as production technology, installation costs and current and future values of capital-goods prices, interest rates and demand for produced goods. In such a setting, the user cost of capital is the most important variable by which monetary policy can influence investment activity. This

1 See Deutsche Bundesbank, Real interest rates: movements and determinants, *Monthly Report,* July 2001, p 31-47.
2 For an introduction to the monetary transmission process, see, for instance, European Central Bank, Monetary policy transmission in the euro area, *Monthly Bulletin,* July 2000, p 43-58; Deutsche Bundesbank, Bank balance sheets, bank competition and monetary policy transmission, *Monthly Report,* September 2001, p 51-70; B S Bernanke and M Gertler, Inside the Black Box: The Credit Channel of Monetary Policy Transmission, *Journal of Economic Perspectives,* 1995, Vol 9, p 27-48; S G Cecchetti, Distinguishing Theories of the Monetary Transmission Process, *Federal Reserve Bank of St. Louis Review,* 1995, Vol 77, No 3, p 83-97.
3 On the first stage see, for instance, Deutsche Bundesbank, The pass-through from market interest rates to bank lending rates in Germany, *Monthly Report,* March 2002, p 49-62.
4 See F Modigliani and M H Miller, The Cost of Capital, Corporate Finance and the Theory of Investment, *The American Economic Review,* 1958, Vol 48, p 261-297.

is also known as the interest-rate channel with respect to investment demand, which has attracted widespread public attention. However, it pays to note that the central bank's influence on real financing costs is very limited. Over the long run, the attempt to push real capital-market rates below their equilibrium rate by means of an expansionary monetary policy would only drive up inflation.[5]

User cost of capital

The user cost of capital is the price of using capital within a period of time. In this it is comparable to wages, which are the price for the services of labour as a factor of production. In the long run, profit-oriented firms will enlarge or decrease their capital stock until the yield of the marginal unit of capital is just enough to cover the cost of its use. For that reason, the user cost of capital is a core element of investment research.

Measuring user cost

The measurement of user cost is only simple if a leasing contract exists. Like a labour contract, the cost of using the factor can then be taken directly from the contractual agreement governing its use. In most cases, however, the situation is more complex. Capital goods are purchased by firms and then provide services over a lengthy period of time; for technical and economic reasons they need to be written down. The total costs must be imputed to each respective period of use in an economically correct way. What needs to be calculated is the expenditure (expressed in terms of units of the manufactured good) which the investor would incur if he purchased a capital good at the beginning of a period, put it to productive use during the period, partially depreciated it, and resold it at the end of the period.

Determinants of user cost

The use of a capital good is initially associated with (arithmetical or effective) financing costs equivalent to a nominal capital-market rate but is reduced by the amount by which the nominal value of capital goods has increased up to the point in time of sale. Thus, the real rate of interest with regard to capital goods price inflation is the key determinant. The real costs of depreciation are an additional component. Finally, the influence of fiscal factors needs to be taken into account. Taxes on earnings, such as corporation tax, have the same effect as increasing the user cost. On the other hand, the user cost falls commensurately with the implicit reduction of the capital good's purchase price by the present value of the tax depreciation allowances which are claimed when the profit is determined, or by government investment premiums.[6]

The credit channel

Imperfect financial markets

Many empirical studies had difficulty explaining the short and medium-run influence of monetary policy on macroeconomic activity

5 See Deutsche Bundesbank, Real interest rates: movements and determinants, loc cit.

6 Under the influence of the taxation of income from capital, the nominal discount rate can depend on the type of financing, which already represents a step away from the simple neo-classical world. On this subject, and on the empirical implementation of the concept of the user cost of capital, see the studies by M A King, Public Policy and the Corporation, London, 1977; M A King and D Fullerton (eds.), The Taxation of Income from Capital, Chicago, 1984; and H W Sinn, *Kapitaleinkommensbesteuerung*, Tübingen, 1985.

solely via the interest-rate channel.[7] The term "credit channel" subsumes mechanisms through which imperfect financial markets amplify conventional interest-rate effects. The starting point is the idea that, with imperfect financial markets, the cost of external refinancing is higher than the riskless rate. The reason for this difference is not the default risk as such. Even in perfect markets the agreed interest rate contains a default premium. However, in this situation the expected payments of the creditor are equal to the expected earnings of the debtor. The default premium is merely compensation for the possibility that the debtor may, under certain circumstances, not meet his payment obligations in full or at all. The (expected) costs of external finance from the point of view of the firm and the lender correspond to the riskless rate.

Information asymmetry and additional costs

On competitive markets this point remains valid from the point of view of risk-neutral lenders even if imperfections exist. However, if there is information asymmetry, the debtor will have to pay a premium for debt financing which covers the lender's expected additional costs. There are many possible reasons for such additional costs:

– If the borrower has more information than the lender, the interest rate will contain a lemon's premium which protects the creditor from opportunistic behaviour on the part of the debtor.

– Where the credit relationship is disrupted, costs are incurred for monitoring, assessing and collecting the debt.

– In a theoretical equilibrium the moral hazard problem means that the borrower's scope for action is hemmed in because, for instance, he will be restricted to projects which can be posted as collateral; this creates inefficiencies.

In lending contracts which are entered into given such imperfections, the added costs are internalised with the borrower. The expected costs of external finance are therefore higher for the borrower than the lender's expected return. These additional costs are called the external finance premium, the amount of which depends on the borrower's expected default risk. Like the tax wedge in the capital or labour markets, it creates efficiency losses.

Key role of own funds

The creditor's expected return is equal to the opportunity costs of finance on the side of the debtor, if the latter had internally generated funds at his disposal. That is certainly the case if the other option for using the available funds is to lend them. Therefore one may alternatively speak of a cost differential between external finance and internal finance. This clearly shows that if the total financing volume for an enterprise is given, the level of the premium depends on the amount of own funds or, more precisely, the total value of assets which can be used as a collateral in such a way that the transaction is free of additional costs to the creditor. Above this level, the probability of default will rise, and

7 See R S Chirinko, Business Fixed Investment: A Critical Survey of Modeling Strategies, Empirical Results, and Policy Implications, *Journal of Economic Literature,* 1993, Vol 31, p 1875-1911.

the external finance premium will be an increasing function of the financing volume.[8]

Credit rationing

The chart on page 46 illustrates the relationship in a stylised manner. All enterprises on the rising slope of the curve are financially constrained. Their cost of capital is determined by the difference between the need for finance and own funds. The case of what is called "credit rationing" is merely an extreme type of financial restriction.[9] Credit is rationed if there is no interest rate at which lenders are willing to accept an increase in the lending volume. In a rationing situation an interest-rate hike would give investors an incentive to indulge in excessively risky behaviour and leave too many bad debtors in a bank's portfolio. To keep the expected return from falling, the lender has no choice but to restrict the quantity of loans.[10]

The credit channel ...

A credit channel exists if monetary policy affects not only the riskless rate but also directly or indirectly the external finance premium. One may distinguish between two classes of possible mechanisms. A bank-lending channel presupposes that a segment of debtors has to rely on bank lending for finance. Now, if a monetary policy measure ends up restricting the ability of banks to lend, the financing costs for this group of borrowers tend to rise particularly sharply. The costs of external finance increase, and the demand for real capital decreases. Although the existence of a bank-lending channel cannot be ruled out for Germany, its influence seems to be moderated by banks' liquidity management.[11]

... comprises the bank-lending channel ...

Whereas the bank-lending channel presupposes the existence of a bank as a lender, the balance-sheet channel can be active in any type of lending relationship. What counts is that the borrower's financial status has an impact on the external finance premium. Changes in the credit rating of borrowers then cause reactions of their real demand. If this then results in endogenous procyclical changes in the financial situation of debtors, the mechanism will amplify cyclical movements. This type of interplay in the business cycle is summed up as a "financial accelerator". Such reactions of the financing premium are by no means limited to monetary policy measures but can amplify the impact of any cyclical stimulus.

... and the balance-sheet channel

Financial accelerator – a precondition for the balance-sheet channel

A balance-sheet channel as a part of a more comprehensive credit channel is said to exist if monetary policy influences the financial situation of (potential) borrowers and thereby unleashes real effects. The effects of a monetary stimulus along the balance-sheet channel are primarily direct effects. An expansionary monetary policy, for instance, causes the

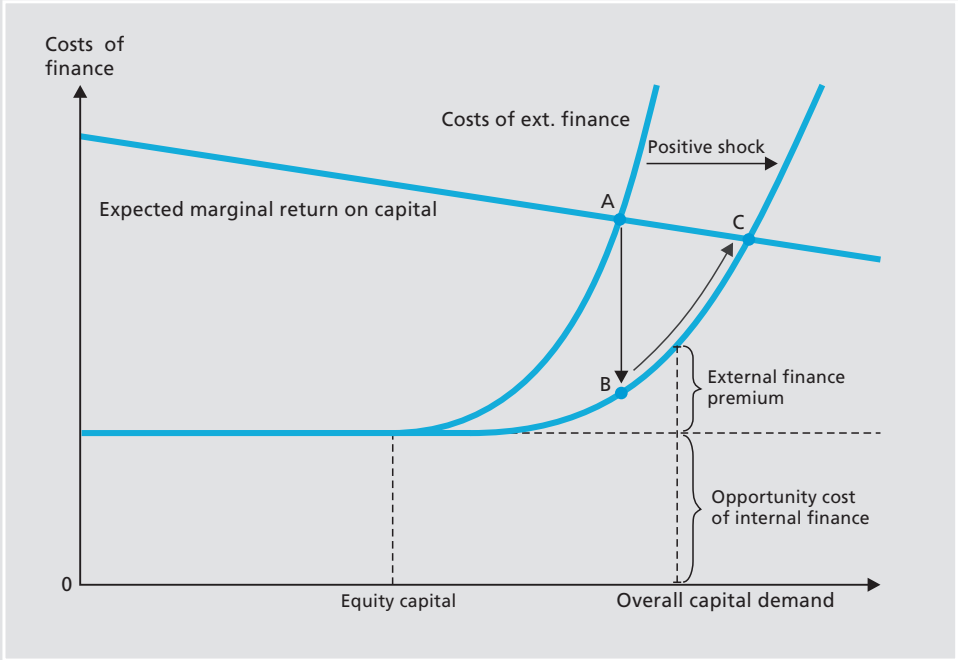
8 Such models are presented by B S Bernanke, M Gertler and S Gilchrist, The Financial Accelerator in a Quantitative Business Cycle Framework, in: J B Taylor and M Woodford (eds.), *Handbook of Macroeconomics*, Vol 1, Amsterdam et al 1999, chapter 21, p 1341-1393, and B S Bernanke and M Gertler, Agency Costs, Net Worth, and Business Fluctuations, *The American Economic Review,* 1999, Vol 79, p 14-31.

9 See J E Stiglitz and A Weiss, Credit Rationing in Markets with Imperfect Information, *The American Economic Review*, 1981, Vol 71, p 393-410.

10 This could be represented in the chart by an interrupted curve.

11 For details on this see Deutsche Bundesbank, *Bank balance sheets, bank competition and monetary policy transmission*, loc cit, and A Worms, *Monetary Policy Effects on Bank Loans in Germany. A Panel-Econometric Analysis*, Economic Research Centre of the Deutsche Bundesbank, Discussion paper 17/01, December 2001.

Capital demand and additional costs of external finance



Deutsche Bundesbank

interest burden on outstanding loans which need to be refinanced over time to fall. That causes profits, and therefore also the ability to generate internal finance, to rise. The chart shows that this cash-flow effect shifts the financing cost curve to the right. In the new financing situation, the demand for real capital is higher, and a sequence of positive net investment sets in, which should bring the firms to a new equilibrium. Similar effects are produced by all circumstances which influence the probability of default and the credit rating of borrowers at a given financing volume. The effects of changes in the interest rate on asset prices are also direct effects – the prices of marketable balance-sheet assets are naturally important for the collateral limit.

Indirect effects and asymmetry

Moreover, indirect effects may also occur. If consumers or investors increase their final demand because of an expansionary monetary policy measure, upstream sellers encounter additional demand, increasing their ability to raise finance internally. That can intensify cyclical swings due to chain reactions.[12] In addition, the impact of the financial accelerator and the balance-sheet channel are asymmetrical in two respects. One is that only financially constrained enterprises are affected, not all enterprises. The other is that since there are more financially constrained firms in a recession than in a boom, the financial accelerator has a stronger impact in downturns than in boom years.[13]

12 There is a very clear parallel to the Keynesian multiplier-accelerator processes.
13 See B Bernanke and M Gertler, 1999, loc cit.

An empirical study using individual data

Aggregated data insufficient

For a variety of reasons it is difficult to comprehend the monetary transmission process by using aggregated data alone. Econometric studies of the interest-rate channel are hampered by the fact that the macroeconomic real interest rate is endogenous and procyclical. Detecting the financial accelerator is also fraught with problems. The most important empirical implication, namely that different groups of firms are affected differently by monetary policy measures, cannot be recognised in aggregated data.[14]

Cross-sectional dimension is important

For those reasons it makes sense to use individual data to study transmission mechanisms since this also enables the use of the cross-sectional dimension to identify the channels. Such a study was conducted by the Bundesbank as the German contribution to the Monetary Transmission Network (MTN) in the European System of Central Banks.[15] The results obtained by the MTN are very important not least because they permit European countries to be compared directly.[16]

The Bundesbank's corporate balance-sheet statistics

The study was conducted on the basis of financial statements which make up the Deutsche Bundesbank's corporate balance-sheet statistics. This is by far the most comprehensive statistical evaluation of financial statements of German non-MFIs. These data were generated when the Deutsche Bundesbank's monetary market operations were still largely bill-based. The discounting of trade bills made it necessary to check enterprises' credit rating. Up until the end of the 1990s some 70,000 financial statements were collected and processed by the Bundesbank branch offices on average every year.[17] Following a thorough review and inspection, they form the pool of data used for corporate balance-sheet statistics.[18]

An empirical investment equation

The study covers west German manufacturing corporations for the period between 1988 and 1997. Only those companies for which all the necessary data were available were included in the sample. For a first-differenced autoregressive model with three lags and containing growth rates, at least six con-

14 For details see S G Cecchetti, loc cit, p 87 f.
15 The results presented below are based mainly on U von Kalckreuth, *Monetary Transmission in Germany: New Perspectives on Financial Constraints and Investment Spending*, Economic Research Centre of the Deutsche Bundesbank, Discussion paper 19/01, December 2001. The results of the MTN research work were presented on 19 December 2001 at an international conference held in Frankfurt. For a summary of the project's results see I Angeloni, A Kashyap, B Mojon and D Terlizzese, *Monetary Transmission in the Euro Area: Where Do We Stand?*, ECB Working Paper No 114, January 2002.
16 On this see, in particular, J B Chatelain, A Generale, I Hernando, U von Kalckreuth and P Vermeulen, *Firm Investment and Monetary Policy Transmission in the Euro Area*, Economic Research Centre of the Deutsche Bundesbank, Discussion paper 20/01, December 2001, as well as the other country studies cited in I Angeloni et al.
17 Since the beginning of Stage Three of European monetary union on 1 January 1999 corporate loans have been subjected to a credit assessment by the Bundesbank for bank refinancing purposes. Bill rediscounting, though, is no longer part of the package of the European Central Bank's monetary policy instruments.
18 Detailed descriptions of the data base may be found in: Deutsche Bundesbank, The methodological basis of the Deutsche Bundesbank's corporate balance-sheet statistics, *Monthly Report,* October 1998, p 49-64, and E Stöss, Deutsche Bundesbank's Corporate Balance Sheet Statistics and Areas of Application, *Schmollers Jahrbuch*, 2001, Vol 121, p 131-137. With regard to investment demand, the corporate balance sheet data were put to econometrical use by U von Kalckreuth, *Exploring the Role of Uncertainty for Corporate Investment Decisions in Germany,* Economic Research Centre of the Deutsche Bundesbank, Discussion paper 5/00, September 2000, and D Harhoff and F Ramb, Investment and Taxation in Germany: Evidence From Firm-Level Panel Data, in Deutsche Bundesbank (ed.), *Investing Today for the World of Tomorrow: Studies on the Investment Process in Europe,* Berlin et al, 2001, p 47-73.

secutive financial statements are necessary. Once statistical outliers have been eliminated, 44,345 firm/year observations for 6,408 firms are left. In 1996 the total turnover of the companies in the dataset was DM 963.6 billion, or 42.3% of total sector turnover in western Germany and 61.4% of the turnover of manufacturing corporations in all of Germany. The average number of employees per company was 119. That means the sample contains a rather large percentage of medium-sized enterprises, which form the backbone of west German industry.

These data are used to estimate a neo-classical model of demand for the stock of capital which is extended by adding financial indicators. (The estimation equation is explained in depth on p 50 f.) The dependent variable is the investment rate, ie the ratio of gross capital formation to a company's capital stock. Explanatory variables include not only the user cost[19] and real sales growth but also the cash-flow ratio, ie the ratio of real cash flow to the capital stock. In addition, lagged values of the dependent variables are included.

The significance of the interest-rate and credit channels

User-cost elasticities

Since the estimation equation has its origins in a model of demand for the stock of capital, the significance of the interest-rate channel should initially be measured by means of the reaction of the capital demand to changes in its user cost, or more specifically, the percentage change in capital demand if the user cost is increased by 1%. The preferred estimation provides a value of -0.21 for the first year and -0.44 as a long-run reaction to a permanent increase in the user cost. Although the latter value is still clearly below the theoretical reference value of -1 for a Cobb-Douglas production function, the long-run user-cost elasticity seems rather high by European standards. Using the same specification, for instance, a long-run elasticity of -0.28 is estimated for Spain; the value for Italy is -0.20, and for France the estimated long-run elasticity approaches 0.[20] For the United States, a similar estimation produced a long-run elasticity in the vicinity of -0.25.[21]

Financial accelerator has an asymmetrical impact

For a credit channel to exist on top of the interest-rate channel, it is necessary that some of the enterprises be financially constrained and that this affects their behaviour. Ever since the seminal work by Fazzari, Hubbard and Peterson,[22] the typical approach in empirical research has been to use a priori criteria such as firm size, dividend payments and the structure of the capital stock to identify those firms which can be assumed to be financially constrained. If the investment demand of such firms has a greater sensitivity to key financial variables such as cash flow or liquidity, this is claimed as evidence of the existence of a financial accelerator as a precondition for a balance-sheet channel.

19 For details on how the user cost variable is constructed see U von Kalckreuth, 2001, loc cit, Appendix C.
20 See J B Chatelain et al, loc cit. However, Chatelain et al calculate the user cost differently. Using their definition, Germany's user-cost elasticity is estimated as -0.52.
21 R S Chirinko, S M Fazzari and A P Meyer, How Responsive is Business Capital Formation to its User Cost? An Exploration with Micro Data, *Journal of Public Economics 1999,* Vol 74, p 53-80.
22 See S M Fazzari, R G Hubbard and B C Petersen, Financing Constraints and Corporate Investment, *Brookings Papers on Economic Activity,* 1988, Vol 1, p 141-195.

Direct measurement of financial constraints

In order to counter recent criticism of this approach,[23] this study measures financial constraints directly. The groups are formed on the basis of creditworthiness data gathered using the Bundesbank's discriminant analysis procedure.[24] Also, firm-specific changes in the credit rating measured in this manner can be used to measure the impact of the financial accelerator directly and not via the difference in cash-flow sensitivity.

Balance-sheet channel confirmed

The study confirms the existence of a balance-sheet channel in the German monetary transmission process. Poorly rated firms have a greater cash-flow sensitivity than well-rated firms. In addition, their ability to react to the neo-classical determinants of "sales" and "user cost of capital" is distinctly lower. Also, if the creditworthiness ratio is included in the estimated equation as an independent explanatory variable, the impact of an improvement in credit rating (on the basis of the last financial statement) on investment behaviour in the current year is unambiguously positive. On the whole, this must be interpreted as clear empirical evidence that a financial accelerator does exist in Germany.[25]

Simulation to compare relative strength

The existence in Germany of both the interest-rate channel and the balance-sheet channel thus have found empirical support. Yet does that mean these two channels are also equally important to the monetary transmission process? A simulation based on the estimated investment function can be used to assess the relative strength of the two channels. It is assumed that owing to a monetary policy measure the capital-market interest rates relevant to corporate financing will rise from 7% to 8% for a two-year period. The key first phase of the transmission process between intervention on the money market and the adjustment of the yield curve is disregarded here. Further, it is assumed that inflation expectations are not adjusted, ie in this mental experiment a nominal change in interest rates causes expected real interest rates to change commensurately. It must be emphasised that this simulation is only intended to highlight the dynamic characteristics of the estimated investment equation in terms of the relative strength of a given change in the real interest rate along both channels and is not capable of depicting the entire monetary transmission process in all its complexity. Account would need to be taken not only of the formation of expectations regarding monetary policy and the pattern of investment and output prices but also of the formation of the yield curve and the impact on the demand for the produced good.[26]

The reaction of the user cost of capital and the cash flow

The simulated change in the interest rate has two key consequences. One is that it increases the discount rate that enters into the user cost of capital. Its impact on investment spending depends on the estimated user-cost

23 See S N Kaplan and L Zingales, Do Investment-Cash Flow Sensitivities Provide Useful Measures of Finance Constraints?, *Quarterly Journal of Economics,* 1997, Vol 112, p 169-215.
24 See Deutsche Bundesbank, The Bundesbank's method of assessing the creditworthiness of business enterprises, *Monthly Report,* January 1999, p 51-63.
25 Evidence of a financial accelerator in Germany is also contained in N Siegfried, Monetary Policy and Investment in Germany: Microeconometric Evidence for a German Credit Channel, University of Hamburg, Quantitative Macroeconomics Working Paper 1/00, August 2000, and A Behr and E Bellgardt, Investitionsverhalten und Liquiditätsrestringiertheit, *Jahrbücher für Nationalökonomik und Statistik,* 2000, Vol 220, p 257-283.
26 For an example of such an experiment see the simulation study in I Angeloni et al, loc cit.

An estimation equation for investment behaviour

The starting point for the microeconometric investigation is a neo-classical investment function based on a model of demand for fixed assets.[1] Assuming a generalised CES production function, the necessary first-order conditions for a static maximum profit create a linear relationship between the logarithmic demand for the stock of capital and the logarithmic values of the user cost of capital and the level of the firm's activity.[2] The stock demand is translated into a demand for investment flows by relating the relative changes in the desired capital stock to the user cost of capital (UC) and sales (S). By including lagged values of the exogenous and endogenous variables in the regression equation, the adjustment is spread over time. This allows lags in expectation formation, decision-making and purchasing, as well as the impact of installation and fitting costs, to implicitly be taken into account.[3]

Current and lagged values of the ratio of company cash flow to capital stock (CF/K) are entered into the equation to take account of how the capital flow generated in the sales process influences the formation of expectations and the ability to generate internal finance. The estimated investment equation with the investment rate (I/K) as an independent variable is specified as follows.

$$\frac{I_{i,t}}{K_{i,t-1}} = \sum_{l=1}^{L} \alpha_l \frac{I_{i,t-l}}{K_{i,t-l-1}} + \sum_{m=0}^{M} \beta_m \Delta \log S_{i,t-m} + \sum_{n=0}^{N} \gamma_n \Delta \log UC_{i,t-n} + \sum_{q=0}^{Q} \theta_q \frac{CF_{i,t-q}}{K_{i,t-q-1}} + \phi_i + \lambda_t + u_{i,t}$$

Summary of the results of the estimation *

Long-run effects	All firms	Large firms (n ≥ 100)	Small firms (n < 100)	Difference	Good credit rating	Bad credit rating	Difference
User cost of capital, Δ log UC	– 0.435**	– 0.277**	– 0.564**	– 0.287	– 0.524**	– 0.054	0.470*
Real sales, Δ log S	0.380**	0.375**	0.334**	– 0.040	0.467**	0.103	– 0.363**
Cash-flow ratio, CF/K	0.109**	0.078**	0.126**	0.048	0.086**	0.175**	0.089*
Number of firms	6,408	3,355	3,053	.	4,384	1,131	.

***** Additional regressors: a constant and time dummies, both group-specific if necessary. Estimation method: two-stage GMM first-difference procedure according to M Arellano and S Bond, Some Tests of Specifications for Panel Data: Monte Carlo Evidence and an Application to Employment Equations, The *Review of Economic Studies,* 1991, Vol 58, p 277-298. Instruments: the undifferenced values of the endogenous variables and all regressors lagged at least two periods and earlier. The estimation contains the following maximum lags for the explanatory variables: L = 1 for I/K, M = 3 for Δ log S, N = 1 for Δ log UC and Q = 0 for CF/K. The long-run effects given here are the sums of the coefficients on the variables in question divided by one minus the sum of the coefficients on the lagged endogenous variables. The significance of these expressions was tested using the delta method. Variables significant at the 5% level are denoted by a star; two stars indicate significance at the 1% level.

1 The specification follows along the lines of R S Chirinko, S M Fazzari and A P Meyer, loc cit. The difference, however, is that lagged endogenous variables also enter into the equation. For an extensive treatment see U von Kalckreuth, 2001, loc cit, Appendix A. — **2** See R Eisner und M I Nadiri, Investment Behavior and Neo-Classical Theory, *The Review of Economics and Statistics*, 1968, Vol 50, p 369-382. — **3** See R S Chirinko, loc cit, on the implicit and explicit modelling of the investment dynamic. — **4** Formally speaking, a permanent change

α_l, β_m, γ_n and θ_q are the estimated coefficients. The index i denotes the enterprise in question, and t represents time. The values of ϕ_i depend on the composition of the firm's capital stock and, moreover, capture the firm-specific effects. The values for λ_t are time dummies which filter out aggregated shocks, and $u_{i,t}$ is a stochastic error term. None of the other coefficients varies between enterprises.

The user-cost elasticity of the long-term demand for the stock of capital, η_{UC}, corresponds to the sum of all impacts of an increase in the logarithmic user cost of capital on the logarithmic capital stock. Changes in the logarithmic capital stock can be approximated by changes in the rate of investment. A lasting increase in the user cost corresponds to a one-time change in the logarithmic difference. This gives:

$$\eta_{UC} = \sum_{n=0}^{N} \gamma_n \Big/ \left(1 - \sum_{l=0}^{L} \alpha_l\right)$$

An analogous expression measures the significance of a company's level of activity as a sum of the changes in the logarithmic capital stock as a consequence of a permanent change in logarithmic sales, ie a one-off increase in its growth rate. With regard to the cash-flow ratio, though, it makes more sense to observe a one-off inflow of liquidity.[4] From this, too, the above pattern can be used to calculate the long-run effect as a sum of the changes in the capital stock triggered in that manner. Technically speaking, this is a semi-elasticity of the capital demand with respect to the cash-flow ratio. It corresponds to the long-run change in the capital stock as a reaction to an inflow of liquidity, ie to a marginal propensity to spend on capital goods from internal financing.

Enterprises are classified by size according to the average number of employees (n). Their classification into creditworthiness classes is based on the discriminant analysis method used by the Bundesbank.

in the cash flow ratio would lead to a lasting change in the capital stock's growth rate. However, in the long run the cash-flow ratio is endogenous and hinges on the same technology which determines the other parameters of the investment equation. For that reason, permanent changes in the cash flow ratio should not be seen in isolation.

elasticity. The other consequence is that the change in the interest rate leads to an increase in ongoing payments to external providers of capital, which reduces the ability to generate finance internally. The strength of this partial effect is influenced by the indebtedness of a firm, the maturity structure of its external capital and the estimated cash-flow sensitivity of investment.[27]

For the sake of comparison, the effect of the change in the user cost is identified with the interest-rate channel, whereas the impact of a change in the ability to generate finance internally will be used to denote the balance-sheet channel. This classification probably overstates the balance-sheet channel's importance since the dependence of investment on the current cash flow is not only given by financial constraints but also reflects the significance of current profits for assessing the profitability of future projects. By contrast, the importance of the interest-rate channel tends to be understated since a tight-money policy can also lead to shortfalls in orders received by downstream firms, which would negatively affect the sales variable in the investment function.

Dominant position of the interest-rate channel

However, the simulation shows quite clearly that the interest-rate channel is dominant. It causes investment demand to fall, in comparison with the baseline scenario, by 3.90% in the first period and by 3.65% in the second. Through the credit channel, by contrast, investment demand falls by 0.34% in the first period and by 0.41% in the second with respect to the status quo. Compared with the effect of the interest-rate channel, this is not very much. The income effects of increased interest payments, at least, are thus only of minor importance. However, it is possible that the impact of a worsened credit rating might also enter into the mix.

Monetary transmission and the house banking principle

Enterprise size not decisive

A further outcome of the study is interesting from an economic policy perspective, too: the size of a firm does not seem to play a decisive role in the existence of financial constraints in Germany. In the estimates for the period from 1988 to 1997 the cash-flow sensitivity of investment demand was not significantly higher for small enterprises than for the rest of the sample.[28] The user-cost and sales sensitivity of smaller firms is greater than that of large companies, whereas firms with a bad credit rating appear paralysed compared with companies with a good credit rating: the reaction of the former to economic incentives is almost undetectable. On the whole, a clear

27 For details of the simulation see U von Kalckreuth, 2001, loc cit, Appendix D.

28 This outcome confirms an earlier statement by E Stöss on the credit channel and is consistent with a study by D Kalt for Switzerland. M Ehrmann evaluates Ifo business climate indicators and finds that small firms are hit harder by cyclical shocks. However, this is not necessarily attributable to poorer terms of finance. See E Stöss, *Enterprises' financing structure and their response to monetary policy stimuli. An analysis based on the Deutsche Bundesbank's corporate balance sheet statistics*, Economic Research Centre of the Deutsche Bundesbank, Discussion paper 9/96, November 1996; D Kalt, The Credit Channel as a Monetary Transmission Mechanism: Some Microeconometric Evidence for Switzerland, *Schweizerische Zeitschrift für Volkswirtschaft und Statistik,* 2001, Vol 137, p 555-578; and M Ehrmann, *Firm Size and Monetary Policy Transmission: Evidence from German Business Survey Data*, ECB Working Paper No 21, May 2001.

distinction must be drawn between the size of a firm and its creditworthiness.

European comparison

German investment behaviour has a series of special features that set it apart from other European countries. The significance of internally generated finance for current investment behaviour is relatively low.[29] German enterprises are also able to react swiftly and clearly to economic incentives such as changes in the user cost of capital or in sales patterns.

House banking principle

It would seem appropriate to establish a link between the robustness of German enterprises with respect to variations in cash flow and a feature peculiar to the German financial system, the house banking principle.[30] The term "house bank" is used to denote a credit institution which enters a long-term business relationship with a certain company based on an intensive exchange of information and implied insurance against liquidity shortfalls and sharp fluctuations in refinancing costs.[31] The relationship between the company and its house bank is characterised by a sort of exclusivity. It is possible for the enterprise to have business relations with other banks, but it generally has only one house bank.[32]

Reduced information asymmetry and smoother liquidity situation

The intensive attention a bank gives to its customer reduces information asymmetry between lender and borrower. This relieves some of the root cause of financial constraints. The insurance aspect of house banking implies, further, that to a certain extent the bank will maintain its lending even if the customer encounters financial difficulties. On the whole, this makes the financing of entrepreneurial investment projects relatively independent of the given liquidity and financial situation. Another indicator of the significance of the house banking principle in Germany is that the bank-lending channel seems to be weaker in Germany than in France, Italy or Spain. The estimated reduction in bank lending caused by a tight-money policy seems to be relatively low in Germany.[33]

Structural change in the financial system

Studies have shown that in investment demand the interest-rate channel is rather important for monetary transmission in Germany, while financial factors tend to recede into the background. It is natural to interpret this pattern in the light of the special features of the German financial system. However, it must be stressed that all econometric studies, by definition, present a picture of the past.

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29 See J B Chatelain et al, loc cit.

30 On the role of banks in the German financial system see Deutsche Bundesbank, The relationship between bank lending and the bond market in Germany, *Monthly Report,* January 2000, p 33-48. On the house banking principle, see R Elsas, *Die Bedeutung der Hausbank*, Wiesbaden, 2001 (in German only) and R Elsas and J P Krahnen, Is Relationship Lending Special? Evidence from Credit File Data in Germany, *Journal of Banking & Finance,* 1998, Vol 22, p 1283-1316.

31 On this see Deutsche Bundesbank, The pass-through from market interest rates to bank lending rates in Germany, loc cit, and M A Weth, *The Pass Through From Market Interest Rates to Bank Lending Rates in Germany*, Economic Research Centre of the Deutsche Bundesbank, Discussion paper 11/02, March 2002. It is especially in the case of corporate loans, and among these, particularly current-account credit, where the lending rates of many banks react only incrementally to changes in market interest rates. By smoothing interest rates, the institutions accept the risk of temporary fluctuations between their rates and the market rate.

32 See R Elsas and J P Krahnen, loc cit, p 1287.

33 See the comparative study by M Ehrmann, L Gambacorta, L Martínez Pagés, J Sevestre and A Worms, *Financial Systems and the Role of Banks in Monetary Policy Transmission in the Euro Area*, Economic Research Centre of the Deutsche Bundesbank, Discussion paper 18/01, December 2001.

Therefore, it remains necessary to carefully monitor developments in the capitalisation of the corporate sector and the consequences that the structural change currently taking place in the German and European financial system will have for the monetary transmission process. Regardless of that, the complex transmission process between monetary policy and real or monetary variables provides a key argument against unnecessary activity and tinkering with economic policy for short-term gain and in favour of a steady hand and predictability in the context of a medium-term stability strategy.