

Real interest rates: movements and determinants

The real interest rate is an important determinant of the saving and investment behaviour of households and enterprises and therefore of key importance in terms of cyclical development and long-term economic growth. It is therefore vitally important to ask whether the real interest rate level is appropriate and how, if necessary, it can be influenced. Measuring real interest rates is, however, associated with a number of problems as the inflation expected during the investment period cannot be observed directly. Nonetheless, real interest rates contain important information about investment conditions in the capital market and the economy's financing terms. This can be seen from an analysis of real interest rate movements over the past 40 years. An attempt by the central bank to control real interest rates gives rise to a number of problems and must ultimately be rejected. Monetary policy has a direct effect only on the short end of the interest rate spectrum. The attempt to use an expansionary monetary policy to drive long-term real interest rates below their equilibrium value would merely lead, in the medium term, to price increases which would, in turn, be reflected in a higher inflation risk premium and therefore in higher capital costs.

Introduction

Interest rate level as an indicator of macroeconomic growth

Interest is the price paid for the temporary provision of funding. In a state of equilibrium it aligns supply ("saving") and demand ("investment") on the capital market. The saving and investment behaviour of households and enterprises is a key factor for both cyclical development and long-term growth. Therefore, whether the current interest rate level is appropriate and how, if necessary, it can be influenced are questions which assume major importance – not least with regard to monetary policy. The Bundesbank has therefore documented and analysed long-term interest rate movements on the German capital market in a series of articles, in which the focus was on nominal interest rates.¹ By contrast, this article deals primarily with real interest rates and covers a longer period of time.

Concept of the real interest rate ...

In a monetary economy in which money is the unit of measurement for all prices, it is not only important how many monetary units are obtained in return for forgoing immediate access to goods ("saving"), but also how many goods those units will be able to buy in the future; much the same applies to investment. Hence the money interest or nominal interest is adjusted to take account of the price changes which occur during the observation period and saving and investment decisions are based on the real interest rate. Analyses of real and nominal interest rates yield similar results only when the rate of inflation is stable and low. The use of nominal rather than real interest rates can lead to wrong decisions, particularly over longer periods.

In contrast to nominal interest rates, price changes which occur during the time frame of a financial investment or a real investment can only be observed retrospectively. Rather than the real interest rate which is actually realised, economic agents can therefore only use the anticipated real interest rate as a yardstick for their saving or investment decisions.² In the economics literature, reference is made in this connection to the "ex ante real interest rate", as opposed to the "ex post real interest rate", i.e. the real rate of interest which is observed retrospectively. Although ex post real interest rates are interesting as an indicator of the historical interest charged or paid to the economic agents, they are of no direct relevance to their saving and investment decisions.

... and expected inflation

Real and nominal interest rates: correlation and measurement concepts

The Fisher parity links the real interest rate and the nominal interest rate:

$$r = i - \pi^e$$

where r stands for the real interest rate and i for the nominal interest rate with the same maturity; π^e represents the expected inflation

Correlation between nominal and real interest rates ...

¹ See Deutsche Bundesbank, Capital market rate movements since the beginning of the nineties, Monthly Report, November 1996; Interest rate movements and the interest rate pattern since the beginning of the eighties, Monthly Report, July 1991; Interest rate movements since 1978, Monthly Report, January 1983; and Interest rate movements and changes in the interest rate structure in the Federal Republic of Germany since 1967, Monthly Report, April 1978.

² One exception is investment in inflation-indexed bonds. See the box on page 34.

Empirical evidence of the validity of the Fisher parity

An econometric analysis of the link between the nominal interest rate and the rate of inflation is presented here. This connection is closely associated with the name of Irving Fisher, who, in 1930, elaborated the hypothesis which bears his name on the adjustment of the nominal interest rate to the inflation rate. According to the Fisher hypothesis, a 1% increase in the expected rate of inflation leads to a 1% increase in the nominal interest rate. In reality, although there is a marked connection between the nominal interest rate and the inflation rate, it is not necessarily one-to-one as in the Fisher hypothesis. The Fisher hypothesis could, however, apply in the long term and corresponds in this interpretation to a cointegration relationship. If the nominal interest rate and the rate of inflation are cointegrated, this does not imply that the real interest rate is constant (as originally assumed by Fisher) but rather that it is stationary, i.e. a long-term stable real interest rate.

Test for cointegration between the nominal interest rate (three-month money market rate) and the rate of inflation

Sample period: 1961:1–2001:1
(after adjustment for opening values)
Lag: 1–4

Hypothesis on the cointegration rank	Eigenvalue	Trace statistics	Critical values	
			5%	1%
Zero	0.159	34.540	19.96 (5%)	24.60 (1%)
At most 1	0.039	6.547	9.24 (5%)	12.97 (1%)

The above table summarises all the results of a test for cointegration of the three-month money market rate and the rate of inflation. The hypothesis that there is no cointegration can be rejected at the 5% and 1% levels,¹ although, by contrast, there can be no rejection of the hypothesis that there is at most one cointegration relationship. The test therefore explicitly shows that there is one cointegration relationship between the rate of inflation and the nominal interest rate, thus confirming the Fisher hypothesis.

¹ The figure provided by trace statistics is greater than the corresponding critical values. — ² The marginal α must not be confused with the adjustment parameters α_π and α_r of the error correction model. If the marginal α is less than 0.05, the null hypothesis with an error probability of 5%

is. It is then interesting to ask whether the long-term connection between the nominal interest rate and the inflation rate is a one-to-one relationship. The direction taken by the adjustment to the long-term equilibrium between the nominal interest rate and the inflation rate is also important. Answers to these two questions can be obtained with the aid of an error correction model for the nominal interest rate (i) and inflation rate (π) variables as in the following equations.

$$\Delta i_t = \alpha_r (\pi_{t-1} - \beta i_{t-1}) + \varepsilon_{r,t}$$

$$\Delta \pi_t = \alpha_\pi (\pi_{t-1} - \beta i_{t-1}) + \varepsilon_{\pi,t}$$

On the right-hand side of these equations are further lagged variables such as Δi_{t-1} , $\Delta \pi_{t-1}$, Δi_{t-2} , $\Delta \pi_{t-2}$, and so on. However, for the purpose of simplification, these are not written out in detail. In these equations the parameter β describes the long-term connection between the nominal interest rate and the inflation rate and the parameters α_r and α_π describe the short-term adjustment to deviations from the equilibrium. The table below reproduces the results of a test for binding restrictions.

Restricted error correction model used to align the nominal interest rate (three-month funds) and the inflation rate

Sample period: 1961:1–2001:1
(after adjustment for opening values)
Lag: 1–4

LR test for binding restrictions	χ^2 Test statistics	Marginal α^2 restrictions
$\beta = 1, \alpha_\pi = 0$	2.566	0.277

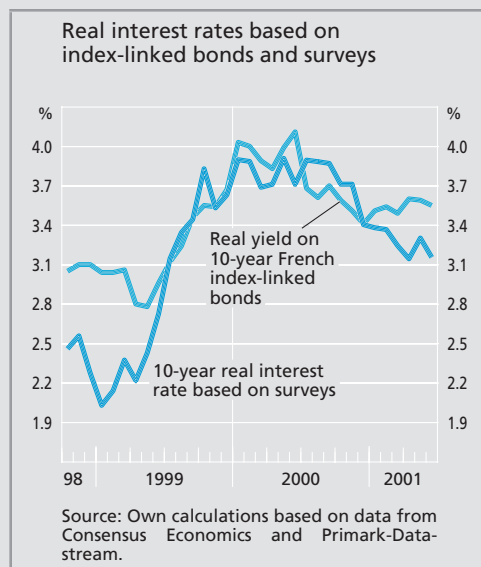
The restriction $\beta = 1$ implies that a 1% increase in the rate of inflation will lead over the long term to a 1% increase in the nominal interest rate, whereas the restriction $\alpha_\pi = 0$ implies that the rate of inflation does not adjust to the equilibrium position. Neither restriction can be rejected.³ The nominal interest rate can be clearly seen to react to the rate of inflation.

can be rejected. In our test the null hypothesis cannot therefore be rejected. — ³ The restriction $\alpha_i = 0$ is, by contrast, rejected, with the result that there is a clear reaction of the nominal interest rate to deviations from the equilibrium position.

Inflation-indexed bonds

In recent years index-linked bonds with the amount repayable and the interest rates linked to general price movements have been issued even outside the circle of high-inflation countries. In the euro area, France has been issuing inflation-indexed bonds (OATis) with ten or thirty-year maturities since September 1998; the interest rate on these bonds and the amount repayable are tied to the development of the French consumer price index (excluding tobacco).¹

The interest rate paid on OATis, however, does not correspond fully to the real interest rate, as, for practical reasons, the inflation adjustment takes place with a lag of three months. A comparison with nominal bonds with the same maturity enables implied inflation rates, known as break-even inflation rates, to be calculated. When evaluating these indicators, it should, however, be noted that the yield of OATis contains a liquidity premium, as the market for index-linked bonds is far less liquid than that for conventional government paper. The chart below shows that this problem was particularly marked in the months immediately following the launch of OATis. Thereafter the real interest rates on index-linked bonds and those based on surveys were very similar.



¹ In accordance with section 3 of the Currency Act (*Währungsgesetz*), index-linking was prohibited in Germany prior to the start of European monetary union; the follow-up regulation governing prices no longer applies to the money and capital market.

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rate for the period in question.³ The Fisher parity is based, however, on restrictive assumptions. For instance, tax aspects are omitted, although, in practice, their role is not negligible. In addition, it is assumed that investors are indifferent as to whether their investment is nominal or real, as long as the yield differential is in line with the expected inflation. The uncertainty surrounding the inflation forecast is assumed, however, not to play a role. In fact, there are signs that investors ensure that they are compensated for running the risk of actual inflation not matching expectations by means of a mark-up of the rate of return. "Inflation risk premia" of this kind also seem to fluctuate over time,⁴ thus also relaxing the connection between real and nominal rates over the short term. Over longer time horizons, nominal interest rates and the rate of inflation move in parallel, with the result that, from a statistical point of view, the Fisher parity cannot be rejected (see the box on page 33). The conditions enabling nominal interest rates to be broken down into a real interest rate and inflation expectations are thus met at least more or less.

... eased by risk premia

In an economy without inflation-indexed bonds (see the adjacent box), alongside nominal interest rates, information about the inflation

Measurement difficulties

³ Strictly speaking, the formula only provides an approximation. The exact form of the Fisher parity is $(1 + i) = (1 + r)(1 + \pi^e)$. Solving for the nominal interest rate i yields $i = r + \pi^e + r \pi^e$. For small values of r and π^e , the latter term is roughly equal to zero and the Fisher parity is simplified as in the equation in the main text of this article.

⁴ See Evans, M. D. D., Real Rates, Expected Inflation, and Inflation Risk Premia, *Journal of Finance* Vol. LIII No. 1, February 1998, page 187 ff.

expectations of market players is needed to calculate the future real interest rate which is relevant in terms of macroeconomic developments. For short-term interest rates, it is usually enough to extrapolate the current inflation rate into the future. For example, the most recently measured rate of inflation is deducted from the interest rate on three-month funds. If applied to long-term interest rates, such a procedure can be misleading since it is implicitly assumed that in the years ahead prices will develop exactly as they did in the past twelve months. As, for instance, the rate of inflation fluctuates in the course of economic activity, this is not generally the case.

Inflation expectations derived from surveys ...

If an *ex ante* real interest rate is to be determined for a longer residual maturity (e.g. several years), information about inflation expectations for that period of time must be available. These inflation expectations can be derived from surveys. Since autumn 1989, for example, the London-based firm Consensus Economics has determined expectations of price developments from surveys of specialists.⁵ Alternatively, inflation expectations can be estimated using econometric procedures. These can either take account of a number of explanatory variables or model the dependent variable solely from its own history. In practice, the forecasting properties of multivariate procedures are often no better than those of simpler models. Hence we estimate inflation expectations using a univariate ARIMA approach (see the box on page 36). This allows us to observe the period before autumn 1989, for which no survey results are yet available. A comparison of the measurement concepts shows that, despite short-term deviations, the

... or econometric estimations

two series tend to develop in a similar manner (see the chart on page 41).⁶ Using the time series model to calculate the *ex ante* real interest rate would therefore appear justified. Only at the start of phases of rapidly rising prices (such as in the wake of the two oil price shocks in the 1970s) or of disinflation (such as the mid-1990s) is it to be presumed that there will be a downward or upward distortion of the inflation expectations.

Irrespective of whether inflation expectations are derived from surveys or whether they are estimated, when calculating real interest rates, the maturity and type of the underlying nominal interest rate as well as the choice of price index become relevant issues. Analyses of real interest rates are only useful if the time horizon for those interest rates covers the whole investment period. In the case of capital projects this is usually several years, for savings decisions it might even amount to decades (for example, for pension provision). Real interest rates for shorter maturities are not very informative in this respect, unless assumptions are made about price and interest rate movements in the subsequent periods. As well as the maturity, the choice of a specif-

Maturity, type of nominal interest rate and choice of price index

⁵ See Deutsche Bundesbank, The information content of survey data on expected price developments for monetary policy, Monthly Report, January 2001, page 35 ff.

⁶ For example, the ARIMA model did not foresee the surge in prices in the lead-up to German unification, while the institutions surveyed expected inflation to persist for an extended period of time. As a result, inflation rates in the first half of the 1990s were clearly below the Consensus Forecast, even if they were above the forecasts of the time series model. In the middle of the decade the opposite occurred. The survey results showed lower inflation expectations than the econometric calculations.

ARIMA method of determining the real interest rate

The rates of inflation were obtained with the aid of the consumer price index. Up to 1992 this index refers to western Germany and from 1993 to the whole of Germany. The time series for the short-term interest rate was derived from the money market rates reported by Frankfurt banks (up to 1990), Fibor (up to the end of 1998) and Euribor (from 1999), in each case for three-month funds. Up to 1973 the long-term interest rate is the yield on all domestic debt securities outstanding and from 1974 the yield on all domestic debt securities outstanding with a residual maturity of five to six years. These two series gradually coincided in 1973, making it easy to form a long series. All data used are quarterly figures and have not been seasonally adjusted in order to ensure that the analysis is not affected by the adjustment procedure.

The formation of expectations of future inflation was modelled using the ARIMA approach. ¹ Plausible results were yielded by an ARIMA(0,1,2) approach ² of the type

$$\Delta \log p_t = \theta_0 + \varepsilon_t + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2}$$

where $\Delta \log p_t = \log p_t - \log p_{t-1}$ is the change in the logarithmic price level. The ε_t are independent, identically distributed random variables. Starting with the period from 1955 to 1960, this ARIMA model was used, in each case for a period of five years, to forecast the development of inflation over the next five years (or, more precisely, 5½ years). The estimation and forecasting period was thus successively shifted forward (five-year window). This procedure guarantees that only current and historical data are taken into account for the inflation forecast. However, it is flexible enough to take account of structural changes. ³

¹ Within the framework of an ARIMA (autoregressive integrated moving average) approach, the development of a non-stationary variable is reproduced using its lagged values and past forecasting errors. An introduction to the modelling and forecasts of ARIMA models is given in chapter 2 of Mills, T. (1999), *The Econometrics of Financial Time Series*, Cambridge. —

² The inclusion of autoregressive terms led to very erratic and implausible inflation forecasts. — ³ On a very similar procedure which also works with a five-year window, see Juntilla, J. (2001), *Structural breaks, ARIMA model and Finnish inflation forecasts*, in *International Journal of Forecasting*, Vol. 17, p. 203–230.

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ic nominal interest rate and of a price index is dependent on the issue being analysed precisely. For macroeconomic analyses, a capital market rate and the consumer price index are generally used.⁷ There are sound economic reasons for this. The yield on debt securities outstanding corresponds to the opportunity costs of a financial or real investment, even if the actual financing costs are generally higher. The bank rates relevant to the financing also tend to run parallel to the capital market rates. The consumer price index represents a fair approximation of the overall price level. In addition, capital market rates and the consumer price index are available with only a short time lag.

Real interest rates in theory and in monetary policy practice

In order to assess whether the interest rate level is in keeping with the macroeconomic environment, the concept of a “neutral” or “equilibrium” real interest rate can be applied. This rate reflects economic growth that is consistent with potential output without pressure being put on prices. Deviations of the actual interest rate from the neutral real interest rate therefore signal imbalances, which are ultimately reflected in an overheated

“Neutral” real interest rate ...

⁷ Tax-related aspects are discounted, although their impact on individual investment decisions is not negligible. In addition, it is not possible to calculate a single macroeconomic net real interest rate because of the different tax rates paid by the various investors.

ing of the economy or a recession.⁸ In a world of flexible prices and rational expectations, the actual and neutral real interest rates coincide.⁹ Differences between the two values occur if, because of price rigidities or expectations which are based on incomplete or wrongly processed information, prices are not fully aligned with the real economic circumstances.

... in growth theory...

However, the individual models reach different conclusions about the level and the properties of the neutral real interest rate. In addition, what economic theory has to say relates to the yield rate of productive capital rather than to the real “monetary” interest rate, which is the subject of this article. The two types of real interest rates are related, however, by arbitrage. The growth theory disregards short-term fluctuations in economic activity and generally assumes that the real interest rate is constantly at the equilibrium position. In accordance with the “modified golden rule” of capital accumulation, it corresponds, in a state of equilibrium, to the long-term growth opportunities. These are in turn dependent on demographic growth and the pace of technical progress – plus a time preference factor which reflects households’ willingness to delay consumption and thus to save (see the Annex on page 46).¹⁰

... and in business cycle models

Business cycle theory, however, leaves aside long-term determinants and focuses on the movement of real interest rates in the economic cycle. This is dependent on both the type and the duration of the impulses. The effects of a demand shock on the real interest rate differ from those of a supply shock. The

analysis in the following section shows that real interest rates can fluctuate markedly in the course of the economic cycle. If the growth and business cycle theories are combined, what emerges is a picture of a neutral real interest rate which fluctuates in the short and medium term but which returns to its average or standard value over the long run (see Annex).

In actual economic analysis, unlike the output gap, the real interest rate gap – the difference between the actual and the neutral real inter-

Minor significance in practice

⁸ The concept of the neutral real interest rate is closely related to Wicksell’s “natural” interest rate, which represents a kind of return on fixed assets. If the interest (which roughly corresponds to the nominal capital market rate) diverges from the natural interest rate, this leads, according to Wicksell, to an adjustment of the price level. This, in turn, exerts pressure on the interest, which adjusts to the new circumstances. In the course of a cumulative process, the interest draws nearer to the natural interest rate until, in a state of equilibrium, no further price changes occur. Wicksell’s concept of a natural interest rate takes neither growth nor employment into account. The realisation that there could be various natural interest rates for different growth paths and employment levels caused Keynes, in his “General Theory”, to develop the concept of the neutral interest rate, which presupposes full employment. See Wicksell, K., *Geldzins und Güterpreise*, Jena, 1898, page 93 ff. and Keynes, J. M., *The General Theory of Employment, Interest and Money*, London, 1936, page 243.

⁹ This does not mean, however, that there is necessarily a single value for the neutral real interest rate. In some economic models, such as with overlapping generations or increasing returns to scale, there are several solutions, each of which implies a different neutral real interest rate (see the Annex). The extent to which multiple equilibria of this kind are relevant in practice – or useful for monetary policy – is not, however, completely clear. See Farmer, R. E. A., *The Macroeconomics of Self-fulfilling Prophecies*, Second Edition, Cambridge MA and London, 1999.

¹⁰ In contrast to models with a shorter time horizon, no independent role is attributed here to the capital stock. Rather, it adjusts endogenously to the optimum.

est rate – plays a relatively minor role.¹¹ On the one hand, this has to do with the aforementioned difficulties of measuring real interest rates. In addition, estimations of the neutral real interest rate are associated with great uncertainty. In principle, two approaches are possible. The first consists of estimating the parameters of a macroeconomic model, from which the real interest rate is then calculated. The results are, however, strongly dependent on the exact specification of the underlying model. In addition, it is difficult to determine the statistical confidence intervals. The second approach does not therefore use a coherent model and attempts to estimate the neutral real interest rate from the long-term average of the real interest rates and the changes in the assumed determinants. In the following section we take this second course, thereby limiting ourselves to commenting on the broad movement of the neutral real interest rate, without giving precise information about its level. Because of taxation of the interest received, it is difficult to implement the concept of the real interest rate gap as well. It drives a wedge between the gross interest, which the debtor has to pay, and the net interest rate, which is paid to the creditor. However, the gap between net interest rates – to which considerations about the level of the neutral real interest rate refer – and the gross interest rate is likely to be relatively stable over time.

The central bank has only limited control of real interest rates

Even if it were possible to identify a divergence of the actual and the neutral real interest rate, it needs to be asked – particularly from the perspective of the central bank – whether and how the neutral rate can be

controlled in practice. The opportunities for the central bank to exert an influence on the real interest rate decrease as the interest rate lock-in period increases. By controlling the nominal money market rates, monetary policy can indeed influence the real short-term interest rate owing to a certain sluggishness in the rate of inflation. Ultimately, however, the real interest rate is determined by real economic factors. Over the medium and longer term, therefore, it can be assumed that monetary policy measures are reflected in the economic agents' inflation expectations and will thus lead primarily to a change in the price level as well as in the nominal interest rates. The effect of monetary policy on the real capital market rate therefore tends to be indirect, i. e. via the inflation risk premium inherent in the real interest rate. This risk premium is particularly marked if the rates of inflation are high and unstable. In addition, tax effects also play a role in terms of real interest rate movements.¹² The central bank can only seek to bring about a reduction in the inflation risk premium by eliminating inflation uncertainties as far as possible. This is an argument in favour of monetary policy that is clearly focused on the objective of stability.

¹¹ At the start of the 1990s a special role was attributed for a time to the (short-term) real interest rate in the monetary policy strategy of the US Federal Reserve. Moreover, some monetary policy rules – such as the Taylor rule – are based on a concept of real interest rates which, however, likewise takes account of the short end of the financial market only. See Deutsche Bundesbank, Taylor interest rate and Monetary Conditions Index, Monthly Report, April 1999.

¹² Typically, for bonds or loans the rate of inflation is offset by higher interest rate payments, which are subject to income tax. An increase in expected inflation should therefore lead to a disproportionate rise in interest rates in order to offset the greater tax burden at least in part.

*Effective fiscal
policy*

If the aim is to influence long-term real interest rates, fiscal policy is a far better basis from which to work. In contrast to monetary policy, it has a direct impact on supply and demand on the capital market.¹³ The effectiveness of fiscal policy is confirmed by numerous empirical studies which regularly note a positive correlation between the long-term level of the real interest rate and the government debt or deficit.

Real interest rate movements in Germany

*Real interest
rates relatively
stable over the
long term ...*

According to our estimations, in the past 40 years the expected real interest rate on the German capital market was, on average, 4 % and the real money market rate just over 2¾ % per annum (see the table on page 40). The gap between the real rate of interest and the relevant nominal rate was in both cases around 3 percentage points, which corresponds to the average rate of inflation. Although real interest rates have fluctuated widely within the individual interest rate cycles, the average rates in the different cycles are very similar.¹⁴ The expected long-term real interest rate was at its lowest average level – 3¼ % – in the period from 1994 and peaked, at just over 5 %, in the preceding period (third quarter of 1986 to the first quarter of 1994). The picture for the *ex post* real interest rate is, however, somewhat different; it reached its lowest point in the 1970s and peaked in the 1980s.

*... but with
marked fluctu-
ations in the
shorter run*

The relative long-term stability of real interest rates was accompanied by marked fluctuations over shorter time frames (see the

charts on pages 41 and 42). This is in line with economic theory, according to which, although the real interest rate varies over the economic cycle, it is determined in the long term by factors which are slow to change. An explanation needs to be found, however, for the high volatility of the real interest rate as estimated using an ARIMA model, compared with nominal interest rates. On the basis of the Fisher parity the nominal interest rates would normally be expected to fluctuate considerably more widely. The far smaller volatility of real interest rates derived from surveys points to the fact that the cause is to be found in the modelling of inflation expectations. The volatility of the real interest rate is therefore overstated in the ARIMA approach if “true” price expectations are accurately reflected by the Consensus Forecasts, which are used as an alternative. Over longer time horizons, the econometric approach yields, however, a good approximation of the survey results. The evolution of the nominal and real money and capital market rates since the start of the 1960s is detailed below and viewed against the background of the macro-economic environment. The period before 1961 is excluded from the analysis for two reasons. First, we need a certain amount of lead-time to estimate the time series model from which we can formulate inflation expectations. Second, economic developments

¹³ This is dependent on future tax revenue, which is needed to finance government debt, not being anticipated by the economic agents. The economic theory literature refers to this possibility as the Ricardian equivalence theory, although the vast majority of the empirical studies question its validity.

¹⁴ In each case the interest rate cycles were measured from one low to the next of the nominal yield of domestic debt securities.

Interest rate cycles since 1960

in %, quarterly data

Period	Capital market				Money market	
	Nominal interest rate 1	Real interest rate			Nominal interest rate 5	Real interest rate 6
		ex ante on the basis of ...				
		... estimated inflation expectations 2	... surveys 3	ex post 4		
1960:1 – 2001:1	7.12	4.03	–	4.19	5.94	2.85
Mean value	1.52	1.59	–	1.77	2.56	1.87
Standard deviation						
1960:1 – 1968:4	6.53	4.23	–	3.49	4.47	2.01
Mean value	0.61	0.66	–	0.78	1.21	1.32
Standard deviation						
1969:1 – 1978:2	8.15	3.86	–	3.17	6.91	2.14
Mean value	1.34	2.05	–	1.65	3.00	2.59
Standard deviation						
1978:3 – 1986:2	8.06	3.71	–	5.62	7.28	3.46
Mean value	1.36	1.52	–	2.02	2.65	1.36
Standard deviation						
1986:3 – 1994:1	7.13	5.12	–	4.51	6.93	4.58
Mean value	1.29	1.73	–	1.39	2.15	1.18
Standard deviation						
1994:2 – 2001:1	5.40	3.13	3.30	–	3.88	2.29
Mean value	1.00	0.74	0.71	–	0.83	0.56
Standard deviation						

1 Until 1973 yield on all domestic debt securities outstanding, from 1974 yield on all domestic debt securities outstanding with a residual maturity of five to six years. — 2 Nominal interest rate less estimated inflation rate (see page *) — 3 Five-year nominal interest

rate less expected inflation (Consensus Forecast). — 4 Nominal interest rate less actual inflation, up to third quarter of 1995 inclusive. — 5 Three-month funds. — 6 Nominal interest rate on three-month funds less current rate of inflation.

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in the 1950s took place against the backdrop of post-war reconstruction. Finally, there were regulations on the capital and foreign exchange markets which were only gradually dismantled.

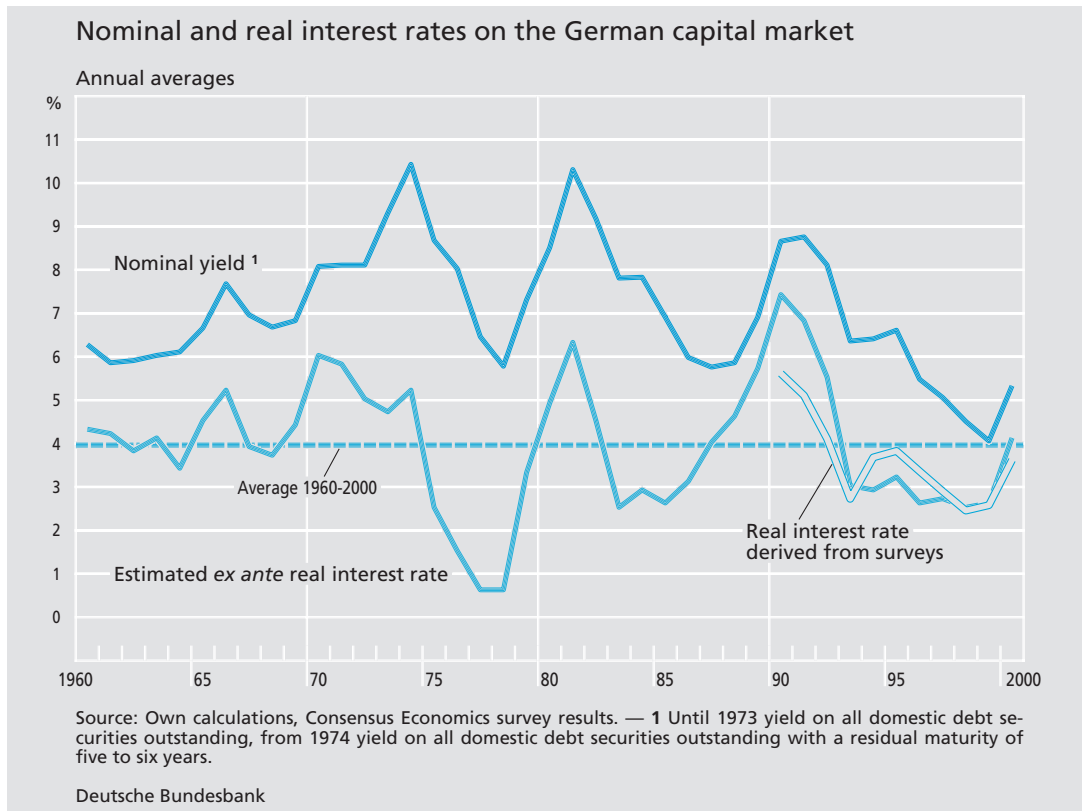
The first half of the 1960s was characterised by strong economic growth of almost 6% per annum on average and full employment. The high surplus on current account of the late 1950s made room, after the revaluation of the Deutsche Mark in March 1961, for a slight deficit. This reverted, however, to a moderate surplus in the following years. Around the start of the decade both the real and the nominal money market rates were at a low level. The nominal capital market rate was around 6%, which produced an expected real interest rate of some 4%. Although

the high level of economic activity in the middle of the decade, together with a gradual tightening of monetary policy, led to an increase in short and long-term real interest rates, these nonetheless remained relatively moderate. During the 1967 recession short and long-term real interest rates then fell back to their previous levels of around 2% and 4% respectively.

Macroeconomic developments in the next six years were characterised by the turmoil on the foreign exchange markets and the gradual demise of the Bretton-Woods system. At the end of the 1960s the German surplus on current account once again increased dramatically despite a booming economy. In addition, there were large capital inflows which had the effect of exerting upward pressure

Interest rates in the wake of the turmoil on the foreign exchange markets

Low real interest rates in the 1960s



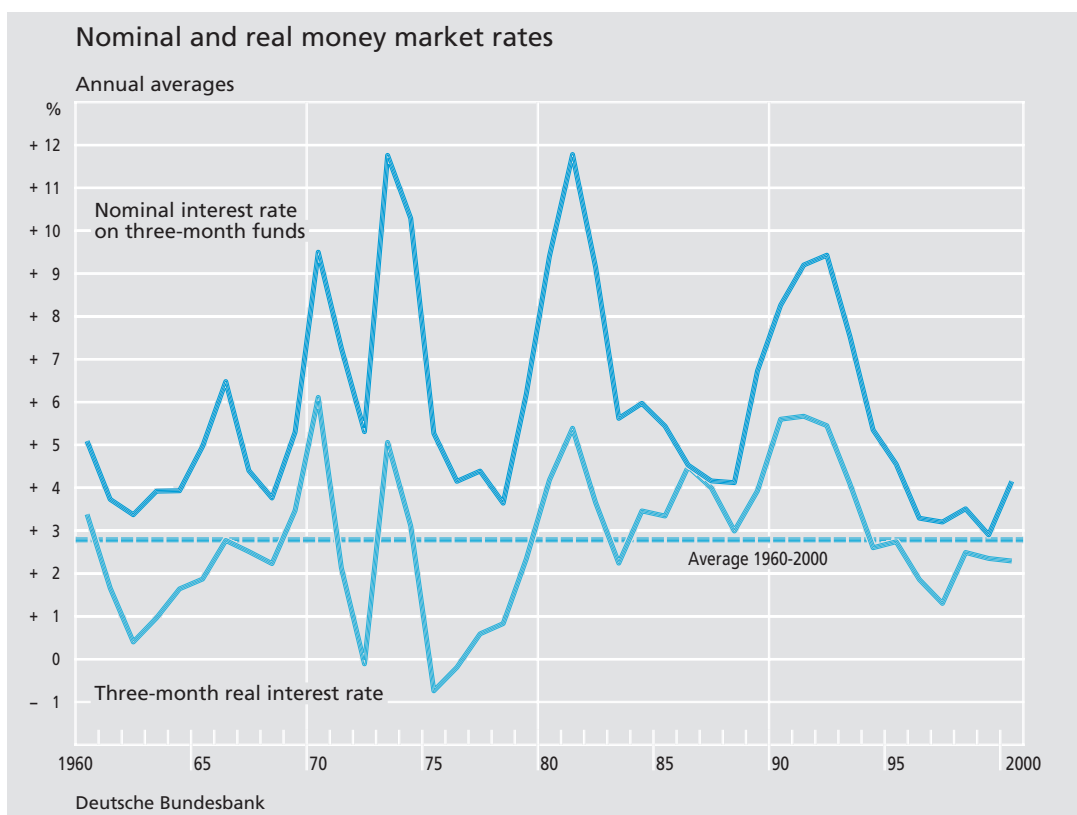
on the Deutsche Mark. This was enhanced by the marked increase in central bank rates, which was needed for cyclical reasons. The Bundesbank was only able to find a way out of the dilemma of whether to safeguard the domestic or the external stability of the currency after the dollar rate was finally floated in March 1973. The Bundesbank took advantage of the newly gained freedom of action and drew in the reins of monetary policy in order to gain control over the rising inflation. Subsequently, short-term real interest rates shot up from around 0% in mid-1972 to almost 8% in the last quarter of 1973.¹⁵ Just as in 1966, the tightening of monetary policy went hand in hand with higher nominal capital market rates. This increase was driven solely by higher inflation expectations; the *ex ante* real interest rate fell from around 6% in

1969-70 to below 5% three years later. At the same point in time the nominal capital market rate exceeded the 10% mark for the first time.

However, real interest rates on the money market remained high for a short time only. The easing of monetary policy against a backdrop of fairly weak monetary expansion and ultimately the economic downturn in 1974 – due, *inter alia*, to the fact that the price of oil quadrupled towards the end of the previous year – coupled with sustained high inflation at first led to a drastic decline in short-term real interest rates, taking them well into the negative. However, this development was overstated by our measure of real money

Decline in interest rates after the 1973 oil crisis

¹⁵ As a yearly average, real money market rates were just over 5% in 1973.



market rates. The use of the actual inflation expected at the time instead of the past expected inflation would presumably show monetary policy to be less expansionary. The capital market rates reacted more moderately to the new macroeconomic environment. Their decline was driven primarily by the expected real interest rate, which fell from just over 5% in 1974 to below 1% three years later.

Against a background of major oil price rises and strong monetary growth, inflation increased again from 1979 onwards – even if, by international comparison, it was very moderate and initially held in check by the strong exchange rate of the Deutsche Mark. However, the upward pressure on the Deutsche Mark soon changed into a downward pres-

sure as a result of the very high interest rates in the United States and Great Britain and a massive current account deficit. This caused the Bundesbank to make a series of interest rate increases, which drove the nominal money market rate up to 12% and the short-term real interest rate to 7% in summer 1981. However, the increase in central bank rates did not pass through fully to the capital market rate, which was just over 10% on average in 1981. Despite the slowdown in the economy, the expected long-term real interest rate in the same period rose to over 6%; in addition to the tense situation on the international capital market, the clear increase in government debt certainly also contributed to this.

Steep increase in interest rates after the second oil crisis in 1979

*Steady descent
from the
interest rate
peak until the
mid-1980s*

Owing to the high level of global interest rates and the weakness of the Deutsche Mark, the descent from the interest rate peak was somewhat hesitant. Nonetheless, the overnight interest rate fell by 7 percentage points to 5% from the end of 1981 to spring 1983. A turnaround began on the capital market, too, although interest rates there declined far more slowly than on the money market. The high interest rates in the United States and the appreciation of the US dollar, which peaked in 1985, played a role in this. The turnaround on the foreign exchange market, which was accompanied by a decline in interest rates on the US bond market, spurred the downward trend of German capital market rates. The yield on domestic debt securities outstanding reached new lows, with values below 6%, and the expected real interest rate fell to a very low level. In 1986 and 1987 the Bundesbank cut the discount rate to a historical low of 2.5%. However, despite low nominal interest rates, as a result of the low or even negative rates of inflation resulting from the oil price slide, short-term real interest rates remained persistently above 3%.

*Rise in interest
rates in the
boom at the
end of the
1980s and at
the time of
German
unification*

As a result of the recovery of the global economy, nominal and real capital market rates began to move upwards again in summer 1987, while, at first, central bank rates remained unchanged, despite the fact that the monetary growth target was exceeded. After share prices plummeted in October, central bank rates were cut even further for a short time, which, however, put a temporary stop to the increase in capital market rates. On the German capital market, interest rates were

pushed up further by the announcement of a withholding tax on interest income, which resulted in massive outflows of capital. Owing to the increasing risks of inflation and the weakness of the Deutsche Mark, the Bundesbank tightened its monetary policy from the second half of 1988. In the following years, in connection with the reunification boom and the accompanying rise in prices, nominal money market rates rose again to more than 9%, while real short-term rates went up to 5%. At the time of reunification, capital market rates achieved a peak value of 9¼% owing to the uncertainties about the resultant burdens. In 1990 the expected real interest rate (based on surveys) was around 5½% as an annual average.

As the special trend of economic activity in Germany came to an end and interest rates began to fall worldwide from 1992 onwards, German capital market yields declined distinctly. The fall in nominal interest rates was driven primarily by the movement of real interest rates, which fell to 2% in winter 1993-94. By contrast, inflation expectations changed only minimally at first. The global rise in interest rates induced by the raising of the central bank rates in the United States at the start of 1994 halted the downward trend of German capital market rates only briefly. As the outlook for stability became increasingly brighter, interest rates fell across the whole maturity range. From the end of 1993 the real three-month rate was consistently below 3%. If the 1970s, which were characterised by extreme macroeconomic disruptions, are excluded, this was the lowest real interest rate level since the 1960s.

*Downward
trend in interest
rates in the
1990s*

*All-time low
in the wake of
tensions on the
international
financial
markets from
1998*

From summer 1997 to spring 1999 there were severe disruptions to the international financial system. The turmoil began in South-East Asia but initially had only a slight impact on the industrial countries. However, this changed after the devaluation of the rouble and the announcement of a moratorium on Russian debt in August 1998, followed by the collapse of a large hedge fund in the United States in the following month.¹⁶ In connection with the crisis in Russia large amounts of foreign funds flowed into the German bond market and pushed the nominal yield on domestic debt securities below the 4% mark for the first time. In Europe, interest rate movements on the money and capital markets continued to be shaped by the interest rate convergence process in the run-up to European monetary union. This ultimately meant that in most countries interest rates were lowered to the German level. At the end of the year and in the first quarter of 1999 fears about an ongoing weakness of the economy put pressure on real interest rates, which fell to below 2%.

*Small interest
rate cycle since
the start of
monetary union*

Subsequently, long-term real and nominal interest rates first rose and then fell back somewhat. This curve showed the influence of interest rate movements in the United States, cyclical and price trends in Europe and the Euro-system's monetary policy. In spring 2001 the real interest rate level on the German capital market – calculated from surveys – was around 2.8%; it was thus more than 1 percentage point below the average of the past 40 years.

All in all, real interest rate movements in the past 40 years reflect a number of influences.

The list is headed by fluctuations in economic activity, which were at times very marked. Then, mainly in the 1970s, there was great uncertainty about the future development of prices. At times, fiscal policies and international influences also played a major role, explaining the rise in interest rates at the start of the 1980s, for instance. The international links between interest rates strengthened notably in the period under review, increasingly eclipsing domestic market influences. The Bundesbank's monetary policy, which was directed primarily towards maintaining the value of money, also affected the movement of real interest rates, particularly at the short end, although the Bundesbank never attempted to gear ongoing monetary policy to real interest rate expectations. Although the real interest rate was used occasionally as an additional indicator for assessing monetary policy, particularly in phases of apparently short-term distortions in the growth of the money stock, it was of no independent significance alongside the money stock. Rather, monetary policy – at least since the fixed exchange rates of the Bretton-Woods system ceased to apply – concentrated on pursuing a policy of monetary discipline to ensure medium-term price stability, with a view to keeping the inflation components in long-term interest rates low. This is stressed by the estimations to determine the validity of the Fischer parity (see the box on page 33). They show that deviations from the long-term

*The real interest
rate as a
reflection of
economic
developments
and policies*

¹⁶ The turmoil had only a limited impact on the German capital market. However, large and otherwise highly liquid market segments were affected temporarily by liquidity shortfalls. See Deutsche Bundesbank, *The impact of financial market crises on the German securities market*, April 2000, pages 15 ff.

equilibrium relationship between the nominal money market rate and the rate of inflation were corrected by an adjustment of the nominal interest rates, rather than by a change in the rate of inflation.

Concluding remarks

Although attractive in theory, concept of the neutral real interest rate ...

The real interest rate level is of key significance for the development of the economy and long-term economic growth. Moreover, in many theoretical models the real interest rate gap – the deviation of the actual from the neutral real interest rate – is used as an indicator of monetary policy stringency.

... of limited practical use

However, it is extremely difficult to implement the concept of the real interest rate gap in monetary policy practice. To start with, measuring the real interest rate level is coloured with great uncertainty. The lack of a reliable method of calculation may possibly lead to serious misconceptions. Even a liquid market for inflation-linked bonds only solves this problem to a certain extent. For practical reasons, indexation needs a certain time lag – as a rule three months. Real money market paper with yields which at first sight might provide a key to the stringency of monetary policy are unlikely to resolve the underlying problems. Even more difficult than estimating the actual real interest rates is calculating a neutral reference rate. Although in recent years significant progress in specifying and estimating dynamic macroeconomic models has been made, these are still far from “ready for production”.

Despite these measurement problems, real interest rates contain important information about investment terms on the capital market and the financing terms of the economy. However, as far as their relevance for monetary policy is concerned, they must be viewed in connection with other monetary policy indicators, in particular the money stock. Gearring monetary policy to reducing the real interest rates must, however, be rejected. On the one hand, the central bank’s scope for exerting a direct influence is limited to the short end of the interest rate spectrum. Although these options also extend to the long end, the direction of impact is uncertain. The attempt to use an expansionary monetary policy to drive long-term real interest rates down could therefore simply lead to price increases in the medium term; these would in turn be reflected in a higher inflation risk premium. The best guarantee for favourable financing conditions is therefore a monetary policy which is clearly oriented towards price stability.

Since the mid-1990s real interest rates have been at a historically low level. The long-term real interest rate derived from surveys is currently well below 3 %. The real money market rate based on the rate of inflation is merely 1 ½ %; based on the core inflation rate, it is likely to be around 2 ½ %. If the long-term average is taken as a measure of the neutral interest rate, the current real interest rate level is no impediment to sustained economic growth. The financing terms for investment continue to be favourable.

Real interest rates as one indicator among many ...

... but not as the monetary policy objective

Real interest rates at a low level since the mid-1990s

Annex

Theoretical considerations related to the neutral real interest rate

The neutral real interest rate is the real interest rate which has neither an expansionary nor a restrictive impact on the actual potential output. As this is a real economic concept, the monetary aspects will not be considered in this Annex.

Let us first consider the long-term equilibrium of the real interest rate from the perspective of growth theory.¹⁷ Households' saving pattern (or time preference) and technical progress are of particular significance. The neo-classical Solow-type growth model assumes the existence of a macro-economic production function with constant returns to scale and assumes that the saving pattern is constant (i.e. a fixed proportion s of the net national product is saved). Given that investment and savings should be equal, it follows that $\dot{K}(t) + \delta K(t) = sY(t)$. The change in the capital stock \dot{K} plus the depreciation $\delta K(t)$ corresponds to the s of the net national product $Y(t)$, i.e. the savings.

In a long-term state of equilibrium, growth is ultimately the result of an increase in the volume of work or the outcome of technical progress; the capital stock adjusts to these exogenous factors. Although an increase in the savings rate would lead to an increase in the capital stock – and hence of the net national product $Y(K)$ – this would not have an impact on long-term growth rates. With an increase in the “effective” output at rate g , in a long-term equilibrium the relationship $sf(k) = (g + \delta)k$ applies, where $f(k)$ is the production function and k the capital stock relative to the effective labour input. Two important connections arise from this relationship. An increase in the pro-

pensity to save s leads to a lower real interest rate and an increase in the rate of technical progress produces a higher real interest rate. That can be explained as follows: if the propensity to save s increases, this promotes capital formation and more production is profitable. If technology remains unchanged, the marginal productivity of capital $f'(k)$ sinks. The real interest rate – the difference between the rate of marginal return of the capital and the depreciation rate – $r = f'(k) - \delta$ therefore falls. A similar line of argument leads to the aforementioned effect of an increase in the growth rate of technical progress.

The simple older growth models were particularly heavily criticised for assuming that the savings rate s is exogenous, rather than the outcome of an optimal intertemporal consumer choice by the economic agents. This shortcoming is removed in Ramsey's growth model (which was developed earlier but only received attention far later on). The basis of this model is a representative household which optimises its consumption over time. The time preference rate, in other words the degree of “impatience”, is in this case exogenous. The actual saving pattern is determined endogenously. An important outcome of Ramsey's model is what is known as the Keynes-Ramsey rule. It states that the optimal (maximal utility) growth rate of per capita consumption is a function of the difference between the real interest rate and the time preference rate.

¹⁷ The real interest rate determinants in the Solow and Ramsey models are summarised in Bliss, C., *The Real Rate of Interest: A Theoretical Analysis*, Oxford Review of Economic Policy, Vol. 15, No. 2, 1999.

If the real interest rate, in other words the real yield rate of a delayed consumption, is greater than the time preference rate, there are advantages to be gained from postponing consumption. The growth rate of consumption will therefore be positive, which has a negative effect on investment. In a state of equilibrium, the real interest rate is a function of the time preference rate, the growth rate of technical progress and population growth. One also talks of the "modified golden rule".¹⁸ The effect of a change in the time preference rate in the Ramsey model is similar to that of a change in the savings rate in the Solow model. If the economic agents' time preference rate declines – i. e. present consumption is weighted less than future consumption – households save more and the real interest rate falls. In the Ramsey model, much as in the Solow model, a rise in the rate of technical progress leads to a rise in the real interest rate.

Unfortunately, these data do not stand up well to other modifications. For instance, the real interest rate in some models of the endogenous growth theory is completely unrelated to the economic agents' saving pattern. Even more problematic is the situation in growth models with overlapping generations. In these models, such as that developed by Diamond, multiple equilibria can occur, with the result that the real interest rate cannot be clearly defined.

In the comments so far the determinants of real interest rates in long-term balanced growth have been discussed. In addition, however, the effect of temporary shocks on real interest rates is also of interest. This issue can be examined with the aid of more recent simulation models. These are dynamic

stochastic equilibrium models – or DGSE models for short – and represent, in principle, a further development of Ramsey's model.

If the effects of temporary technology and demand shocks are depicted in this kind of model, a temporary positive technology shock has two different effects.¹⁹ Higher productivity raises, on the one hand, the willingness to invest and therefore brings about an increase in the real interest rate, as in the Solow and Ramsey models. As the technology shock is only temporary, household income rises only temporarily and the economic agents attempt to distribute the additional possible consumption over time by increasing their savings. This effect produces a decline in the real interest rate and can overcompensate for the initial effect, with the result that the real interest rate falls temporarily.

By contrast, a demand shock leads to a short-term rise in the real interest rate. This effect is similar to a decline in the savings in the Solow model or to an increase in the time preference rate in the Ramsey model. In the long term, however, the real interest rate changes only if there is a change in the pattern of saving. Positive supply shocks can lead in the short term to a reduction in the real interest rate. However, a lasting increase in the rate of growth of technical progress produces a rise in the long-term real interest rate.

¹⁸ The original golden rule of capital accumulation maximises the net national product in the long-term equilibrium but takes no account of the preferences of the economic agents with regard to the consumption date.

¹⁹ See Neiss, K. S. and E. Nelson: "The Real Interest Rate Gap as an Inflation Indicator" in CEPR Discussion Paper No. 2848, 2001.