Long-term interest rates and exchange rates in the Bundesbank macroeconometric model of the German economy

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Introduction

Long-term interest rates and exchange rates constitute two main channels in the transmission process of monetary policy to financial markets and the real economy. The determination of these rates, therefore, plays an important role in analysing the effects of monetary policy measures. Recent turmoils in bond and foreign exchange markets have stressed again the influence which these asset prices exert on the stability or instability of economic developments. Moreover, the Maastricht treaty underlines the importance of stable exchange rates and relatively low long-term interest rates as convergence criteria on the way to the European Monetary Union.

Estimated equations explaining long-term interest rates and exchange rates are integrated into the Bundesbank's macroeconometric model of the German economy which has recently been reduced to a size of about 140 equations[1]. This model is based on quarterly data from the first quarter of 1975 to the fourth quarter of 1995, with figures after the third quarter of 1990 extended to total Germany, i.e. including eastern Germany. Monetary policy is exogenous to the model, with no reaction function or monetary policy rule relating official interest rates to target variables. The following sections of the paper describe the determination of interest rates and exchange rates within the model as well as the dynamic properties of the equations. An annex reproduces the estimated equations and gives a list of the variables.

1. Determination of interest rates

In the model, the determination of interest rates in the long run is based on the so-called Fisher equation which relates the nominal long-term interest rate r to real returns from the stock of physical capital ρ, the expected inflation rate π^e and a risk premium ε:

$$r=\rho+\pi^e+\varepsilon$$

It is assumed that in the long run when all adjustments have occurred expected inflation is fully reflected in nominal interest rates. Apart from the nominal long-term interest rate, which is approximated in the model by the yield on government bonds with residual maturities of 9 to 10 years, none of the remaining variables in this equation can be observed. The long-run real return from physical capital depends on time preferences of economic agents and on various marginal rates of substitution and transformation. It moves only very slowly and can be approximated either by the growth rate of potential output or a constant. In the model, the real return has been estimated as a constant. Inflation expectations can be formed in a rational way by using all informations available in the model or in an adaptive way by correcting expectation errors, i.e. deviations between the actual and the expected inflation rate in the previous period. In fact the model uses the following adaptive expectation formation process:

$$\pi^e=\pi^e_{-1}+\lambda\left(\pi_{-1}-\pi^e_{-1}\right)=\lambda\pi_{-1}+(1-\lambda)\pi^e_{-1}$$

1 A previous version of the model has been described in Deutsche Bundesbank, *Macroeconometric model of the German economy*, Frankfurt am Main, April 1994.

The best fit could be obtained by setting the coefficient λ to 0.1, which results in a fairly slow adjustment to previous inflation rates. The risk premium proved very difficult to estimate. Relating it to the government debt to GDP ratio which has increased over the estimation period led to implausible estimates of the real interest rate. Therefore, it was assumed in the model that the risk premium was constant over the estimation period which does not seem an implausible assumption for the past German development.The actual nominal long-term interest rate adjusts to the long-run rate which equals the sum of a constant (real returns and the risk premium) and the (expected) inflation rate. In this adjustment process, influences from monetary policy as well as from foreign capital markets seem to be of some importance. Monetary policy impulses are transmitted to long-term interest rates through changes in short-term interest rates (i). But these direct influences are of a temporary nature only. In the long run, monetary policy effects long-term interest rates through its impact on the growth of the money stock and, thereby, on the inflation rate. Apart from domestic factors, foreign long-term interest rates exert some influence on German rates. But, probably due to multicollinearity problems, it was not possible to estimate the size of these effects with plausible results. Fears of a heavy burden on capital markets from German unification increased long-term rates in the first half of 1990. This has been considered in the equation by including a dummy variable *DWU*. Thus the adjustment process in the determination of long-term interest rates is described by the following equation:

$$\Delta r = \alpha_1 + \alpha_2\, DWU_{+2} + \alpha_3 \Delta i + \alpha_4 \Delta r_{-1} + \alpha_5 \left(\pi^e_{-4} - r_{-4}\right)$$

In the long-run when expected inflation equals actual inflation, the long-term interest rate is determined by a constant and the inflation rate:

$$r = \frac{\alpha_1}{\alpha_5} + \pi$$

The value of the constant which approximates real returns from capital and risk premia has been estimated at 3.28 %. As Chart 1 shows interest rates have been nearly stationary in the past twenty years. Inflation rates, on the contrary, have followed a decreasing trend, so that "real interest rates" have increased. As there are no reasons for an increase in real returns from physical capital, this development can be interpreted either as a rise in risk premia or as a very slow adjustment of nominal long-term interest rates to lower inflation rates.

Short-term interest rates on the money market are mainly determined by monetary policy. The Bundesbank uses rediscount facilities which are charged at the discount rate, *DIS*, to provide central bank money on a longer-term basis[2]. Marginal refinancing needs, on the other hand, are satisfied by lombard loans which form the most expensive way of refinancing at the lombard rate, *LOMS*. The repurchase rate, z, for regular open market transactions normally ranks between these two rates, depending nonlinearly on the liquidity situation which has been approximated in the model by the ratio of excess reserves of banks, *ZBGD*, to the total stock of central bank money supply, *ZEBA*:

$$z = DIS + GMST * \left(LOMS - DIS\right)$$

$$\ln\left(\frac{GMST}{1.25 - GMST}\right) = \alpha_1 + \alpha_2 \ln\left(\frac{GMST_{-1}}{1.25 - GMST_{-1}}\right) + \alpha_3 \sum_{i=0}^{3} \frac{ZBGD_{-i}}{ZEBA_{-i}}$$

2 The various monetary policy instruments have been described in detail in Deutsche Bundesbank, *The monetary policy of the Bundesbank*, Frankfurt am Main, October 1995. See also Hermann, H. and W. Jahnke, "The interest rate policy transmission process in Germany", in Bank for International Settlements, *National Differences in Interest Rate Transmission*, Basle, March 1994 and Jahnke, W. and H.-E., Reimers, "The transmission of monetary policy in the economic model of the Deutsche Bundesbank for the German economy", in Bank for International Settlements, *Financial Structures and the Monetary Policy Transmission Mechanism*, Basle, March 1995.

Chart 1

Interest rates and inflation in Germany from 1975 to 1995

In % p.a. or in percentage changes

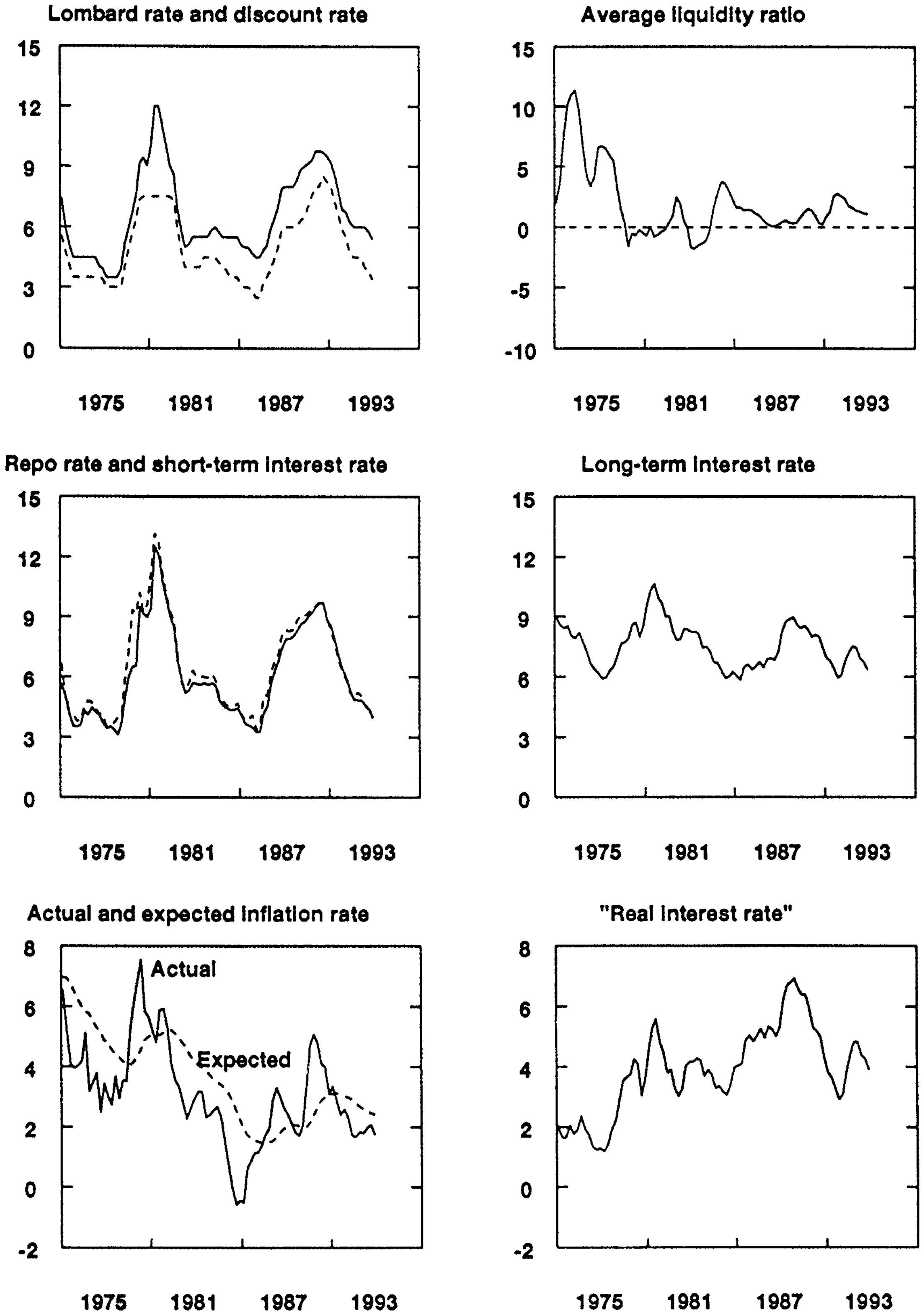

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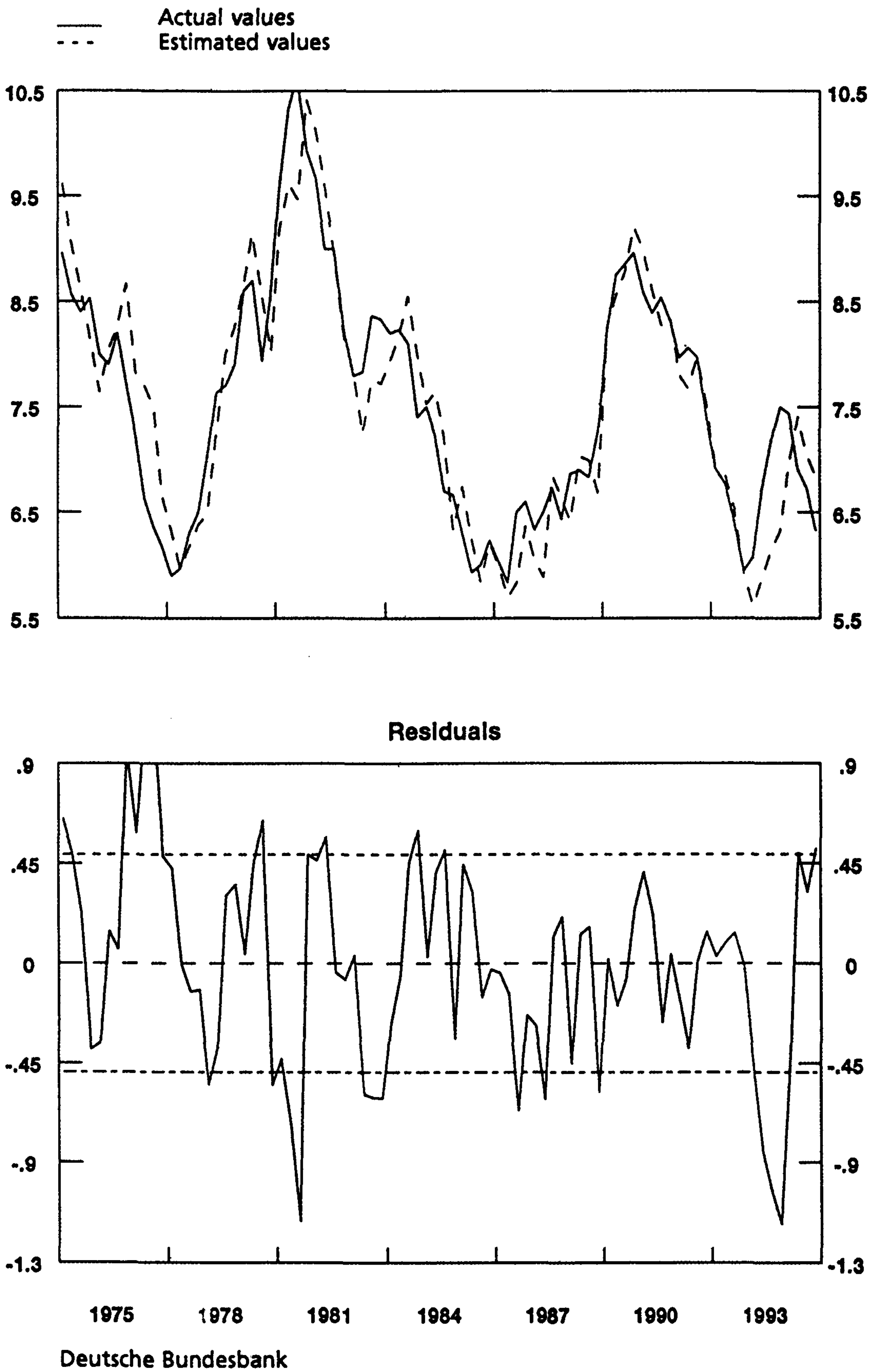
Chart 2

Interest rate equation: yield on government bonds

With residual maturities of 9 to 10 years, % p.a.



Money market rates for three month funds mainly depend on the repurchase rate. Additionally their development is influenced by short-term rates in the Euro-dollar market (i^*) and by the inflation rate. Interest rates on the money market are thus described in the model by the following equation:

$$\Delta i = \alpha_2 \Delta z + \alpha_3 \Delta i^* + \alpha_4 \pi + \alpha_5 (z_{-1} - i_{-1})$$

Changes in official rates as well as changes in liquidity policy are transmitted, in the first stage, to short-term money market rates and, in a second stage, to long-term interest rates. (Chart 2).

2. Determination of exchange rates

The effective exchange rate of the D-Mark against foreign currencies is described in the model by a weighted index, the so-called external value of the D-Mark against the currencies of 18 industrial countries. This index has been disaggregated into the external value against the US-dollar (Chart 3), the external value against the currencies of the countries participating in the exchange rate mechanism of the European Monetary System (ERM), and the external value against the currencies of the remaining countries, the respective weights being the trade shares[3] (equation 7 in the annex). The external value of the D-Mark is the equivalent of the inverse of the domestic price of foreign currencies. An increase (decrease) of this value represents an appreciation (depreciation) of the D-Mark.

The determination of exchange rates in the model is based on interest rate parities as well as on purchasing power parities[4]. Comparing investments in assets denominated in domestic or in foreign currencies the following applies:

$$i - (i^* + \beta) = e^e - e$$

After all arbitrage transactions have occurred the difference between domestic and foreign interest rates plus a risk premium β, resulting e.g. from imperfect capital mobility or risk-averse investors equals the expected change in the exchange rate (where e is the natural logarithm of the exchange rate and the superscript "e" denotes the expected value). In the long run exchange rate expectations in the model converge to the relation between foreign and domestic prices, i.e. to purchasing power parity (where p^* and p are the natural logarithms of foreign and domestic price deflators for final demand respectively):

$$e^e = \alpha_1 + \alpha_2 (p^* - p)$$

By inserting and rearranging the following estimated exchange rate equation has been derived, where the coefficient α_3 takes into account that the interest rate differential has been approximated by short-term interest rates whereas the expectations apply to the long run:

$$e = \alpha_1 + \alpha_2 (p^* - p) + \alpha_3 (i^* - i) + \beta + u$$

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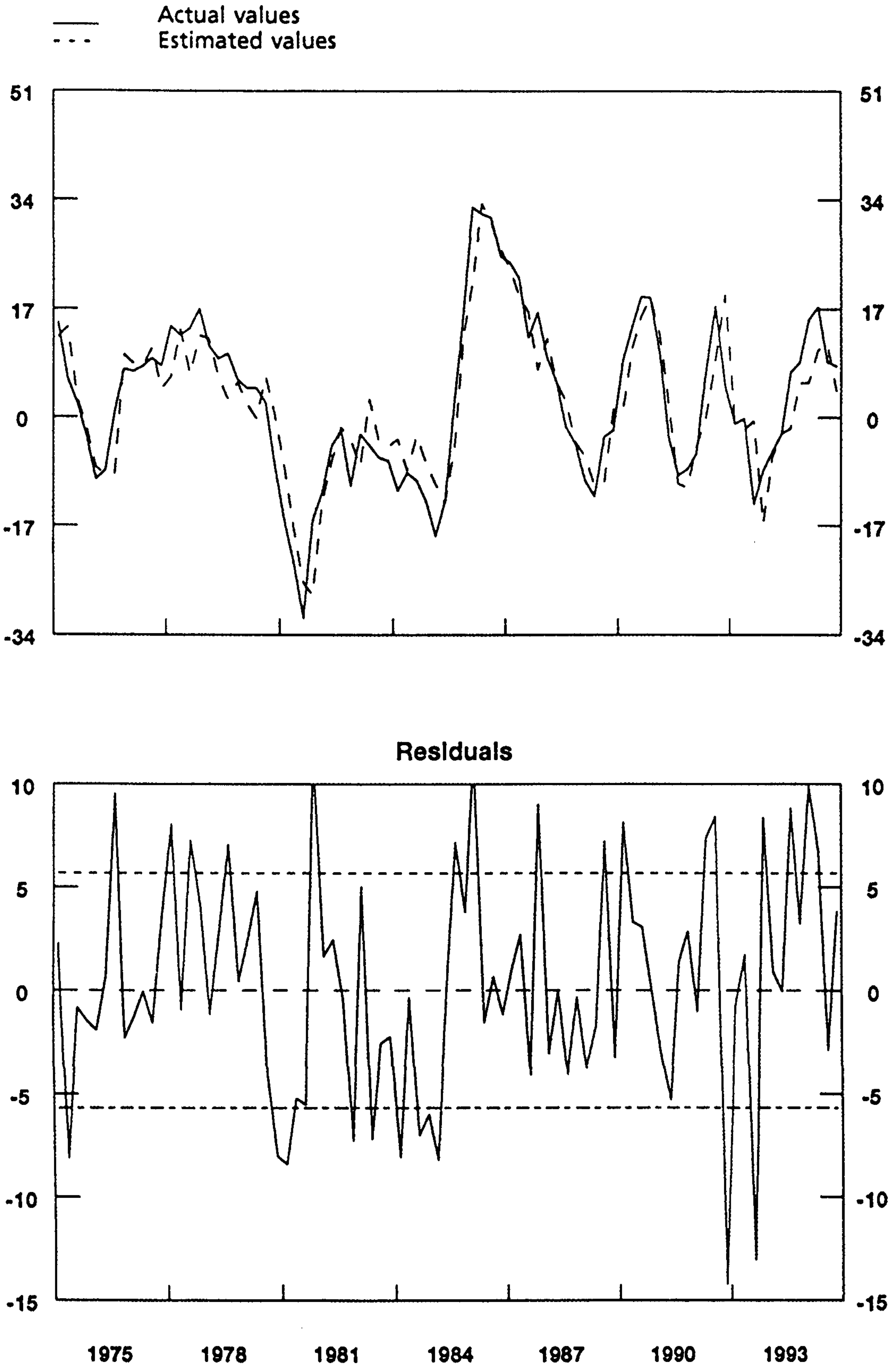
3 See Deutsche Bundesbank, "Revision of the method of calculating the external value of the Deutsche Mark and foreign currencies", *Monthly Report*, April 1989.

4 The long run validity of purchasing power with respect to single currencies as well as the interaction of purchasing power and interest rate parity has been analysed in Deutsche Bundesbank, "Trends and determining factors of the external value of the Deutsche Mark", *Monthly Report*, November 1993. See also MacDonald, R., "Long-Run Exchange Rate Modelling - A Survey of the Recent Evidence", *IMF Staff Papers*, 42, 1995.

Chart 3

Exchange rate equation: external value of the D-mark against the US-dollar

Logarithmic change against the previous year, in %



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The coefficient α_1 deviates from zero mainly because the foreign price deflators and the external values of the D-Mark are based on end-1972 = 100 whereas domestic prices are based on the year 1991 = 100. Furthermore the existence of transportation costs and tariffs may have some importance. The coefficient α_2 equals 1 for the ERM currencies, but is below 1 for the US-dollar and the other currencies which means that price differentials are not fully compensated in exchange rate changes, at least not over the medium term. Real exchange rates will change accordingly. This could, in part, be explained by the fact that the price deflators for domestic and foreign total demand contain different and non-neglectable amounts of nontraded goods. Moreover, when adjustment processes are slow, the sample available over the recent floating period seems to be relatively short.

The interest sensitivity of the US-dollar is found to be much higher than the reaction of the other currencies to changes in interest rate differentials. Attempts to estimate the risk premia β by introducing the net foreign assets to GDP ratio into the equation failed. Therefore it was assumed that β is constant.[5] The short-run adjustment of exchange rates to the longer-term relations has been estimated by an error correction process, depending on changes in price and interest rate differentials:

$$\Delta e = \alpha_1 \Delta(p* - p) + \alpha_2 \Delta\left(p^*_{-1} - p_{-1}\right) + \alpha_3 \Delta(i* - i) + \alpha_4 \Delta e_{-1}$$
$$+ \alpha_5 \Delta e_{-2} + \alpha_6 \sum_{i=1}^{4} u_{-i}$$

3. Effects of shocks in official rates and in inflation on interest rates and exchange rates

The various interest rate and exchange rate equations described in the previous sections build, together with expectation formation, a small bloc of the complete macroeconometric model of the Deutsche Bundesbank for the German economy. The main exogenous variables to this small bloc model, consisting of 15 equations, are the domestic official interest rates, i.e. the lombard rate and the discount rate, the Euro-dollar rate for three-month funds as well as domestic and foreign price deflators for final demand. To demonstrate the dynamic properties of the estimated equations two different shocks have been simulated with this bloc model. The first one consists of an increase in official interest rates by 100 basis points for two years (1988 and 1989 as an example) and a return to base line values, i.e. to actual values, thereafter. The second simulation describes the effects of a temporary two-year increase in the domestic inflation rate by 1 percentage point, all other exogenous variables[6] being unchanged, as in the first simulation.

A dynamic base line simulation of the estimated equations building the small bloc model over the whole estimation period from 1975 to 1995 shows, no doubt, that there are periods of large deviations from the actual values, especially in the exchange rate of the Deutsche Mark (DM) against the US dollar (Chart 4). These deviations are not systematic, however, and in the long run, the variables tend to return to their observed values.

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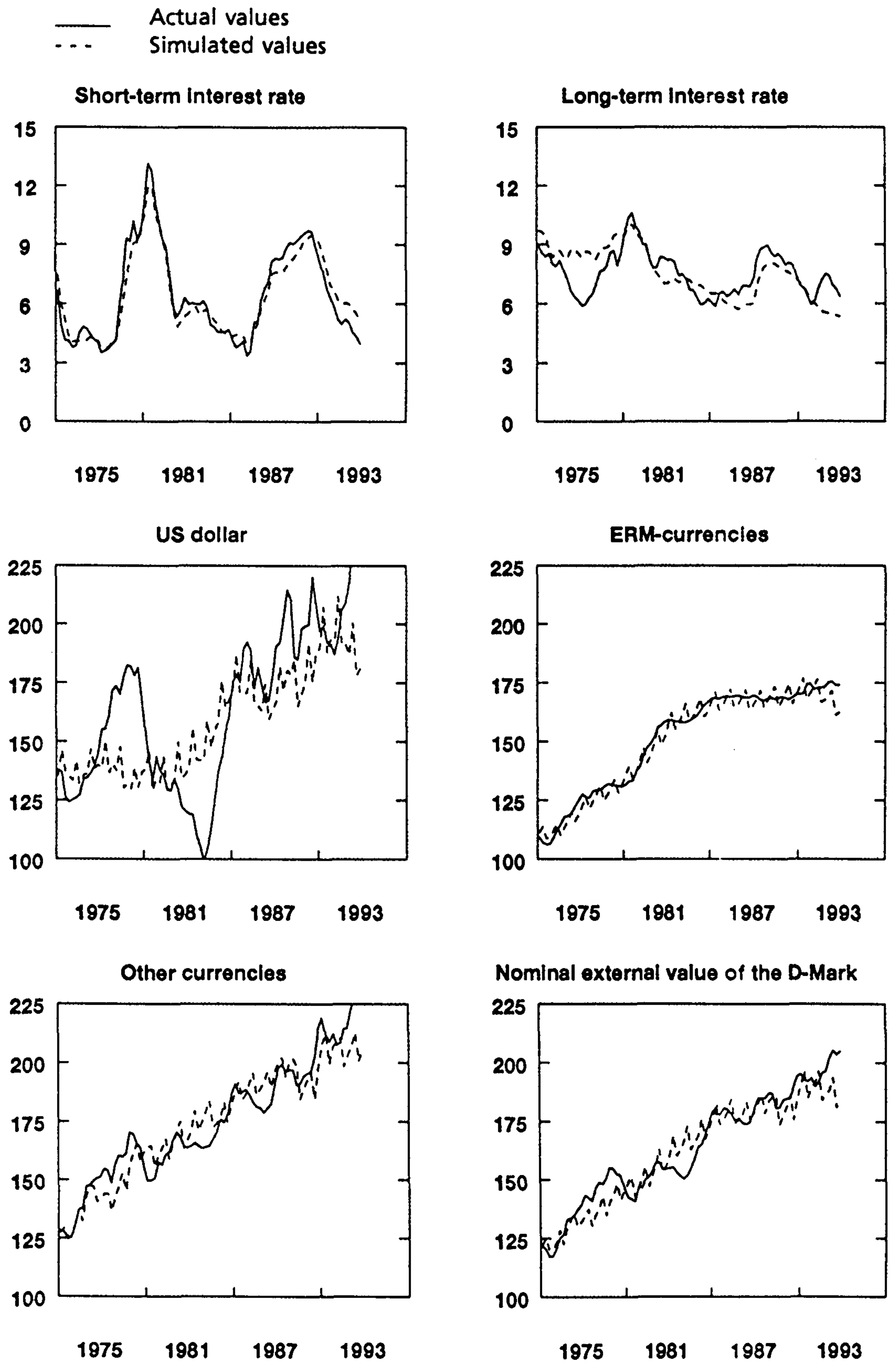
5 Similar results with respect to the external assets ratio have been described in Deutsche Bundesbank, "Overall determinants of the trends in the real external value of the Deutsche Mark", *Monthly Report*, August 1995.

6 In the complete model the price deflator for final demand is an endogenous variable.

Chart 4

Dynamic simulation of the interest rate and exchange rate equations in the econometric model of the German economy



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The increase in official interest rates, followed by a decrease to base line levels, is transmitted almost completely and contemporaneously to short-term money market rates (Chart 5). The yield on government bonds, on the contrary, reacts only in a restricted manner. Its increase amounts merely to 30 basis points at the most. When short-term rates have returned to their base line levels long-term rates fall by 17 basis points below their base line. But in the long run the long-term interest rates, like the short-term rates, return to their base line levels. In reaction to the increase in interest rates the DM appreciates by 0.8 % at the peak (2.2 % against the US dollar, 0.7 % against the ERM currencies and 0.5 % against the other currencies). When the short-term interest rates have returned to their base lines in the third year after the shock the DM depreciates afterwards by the same amount. The level of the exchange rate, therefore, returns to its base line.

A temporary increase in the inflation rate by 1 percentage point for two years raises the price level by 1 % in the first year after the shock and permanently by 2 % from the second year on (Chart 6). Expected inflation follows the change in actual inflation with considerable delay. After two years inflation expectations are 0.6 % higher than in the base line. But as the actual inflation rate then returns to its base line, inflation expectations likewise return to the base line in the long run. The higher inflation expectations raise the long-term interest rate by 30 basis points at the most. In the long run government bond yields will return to their base line levels too. Only a permanent change in the inflation rate will be transmitted completely to the level of long-term interest rates. The assumed increase in domestic inflation and the induced changes in interest rates with unchanged foreign prices and foreign interest rates depreciate the DM by 2½% at the most. As the inflation rate and interest rates after two years return to their base line levels the depreciation rate returns to zero. After all adjustments have taken place the DM has depreciated by 1.6 %. Since the domestic price level has increased by 2 % and the foreign price level has been assumed unchanged, the real exchange rate (which depreciates temporarily because the domestic price level increases more slowly than the nominal exchange rate depreciates) will be changed slightly in the long run (incomplete purchasing power parity).

In the complete model of the German economy, domestic prices are endogenous. But as the model does not contain a monetary policy reaction function, official interest rates are still exogenous. In addition to the two simulation experiments with the small bloc model, a temporary increase in official interest rates by 100 basis points (in the years 1988 and 1989) has been simulated with the full model. The reaction of long-term interest rates and exchange rates corresponds completely to the reaction in the small bloc model. As Chart 7 shows, a temporary change in monetary policy only results in temporary changes in real variables. In the long run the real long-term interest rate, the real effective exchange rate, the real stock of money, real GDP and real wages return to their base line levels. This is true also, regarding prices, wages and other nominal variables, although wages lag more than other variables due to the prevailing rigidities in the labour market. After the economy has been exogenously shocked by the temporary change in interest rates the system returns to the base line with damped oscillations. In a model with adaptive expectation formation it seems necessary to change official interest rates permanently to obtain a permanent success in reducing the stock of money and the level of prices.

Chart 5

Effects of an increase in Bundesbank interest rates by 100 basis points for two years on market interest and exchange rates

Deviation from base line in % or in percentage points

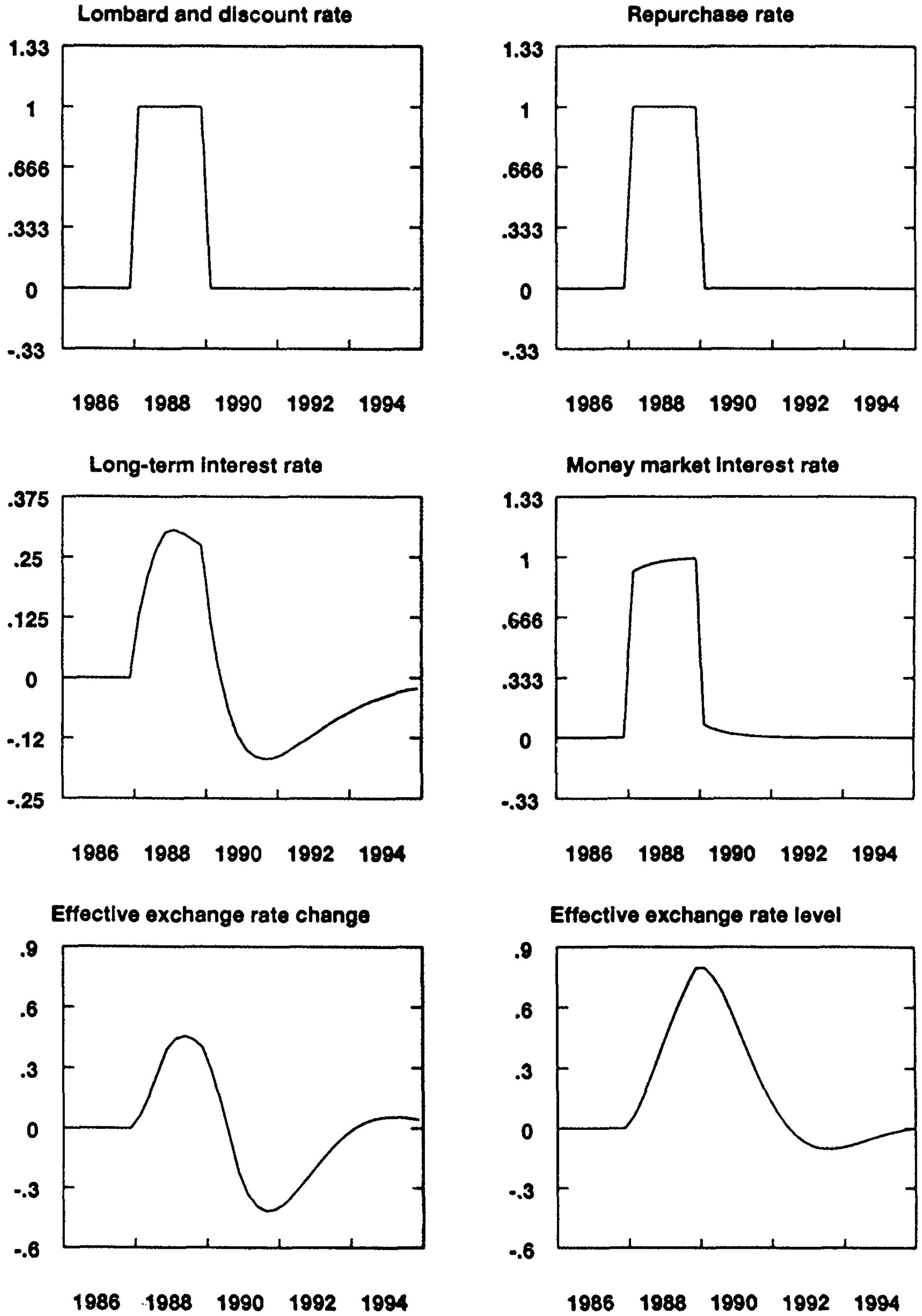

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Chart 6
Effects of an increase in the inflation rate by 1 percentage point for two years on market interest and exchange rates
Deviation from base line in % or in percentage points

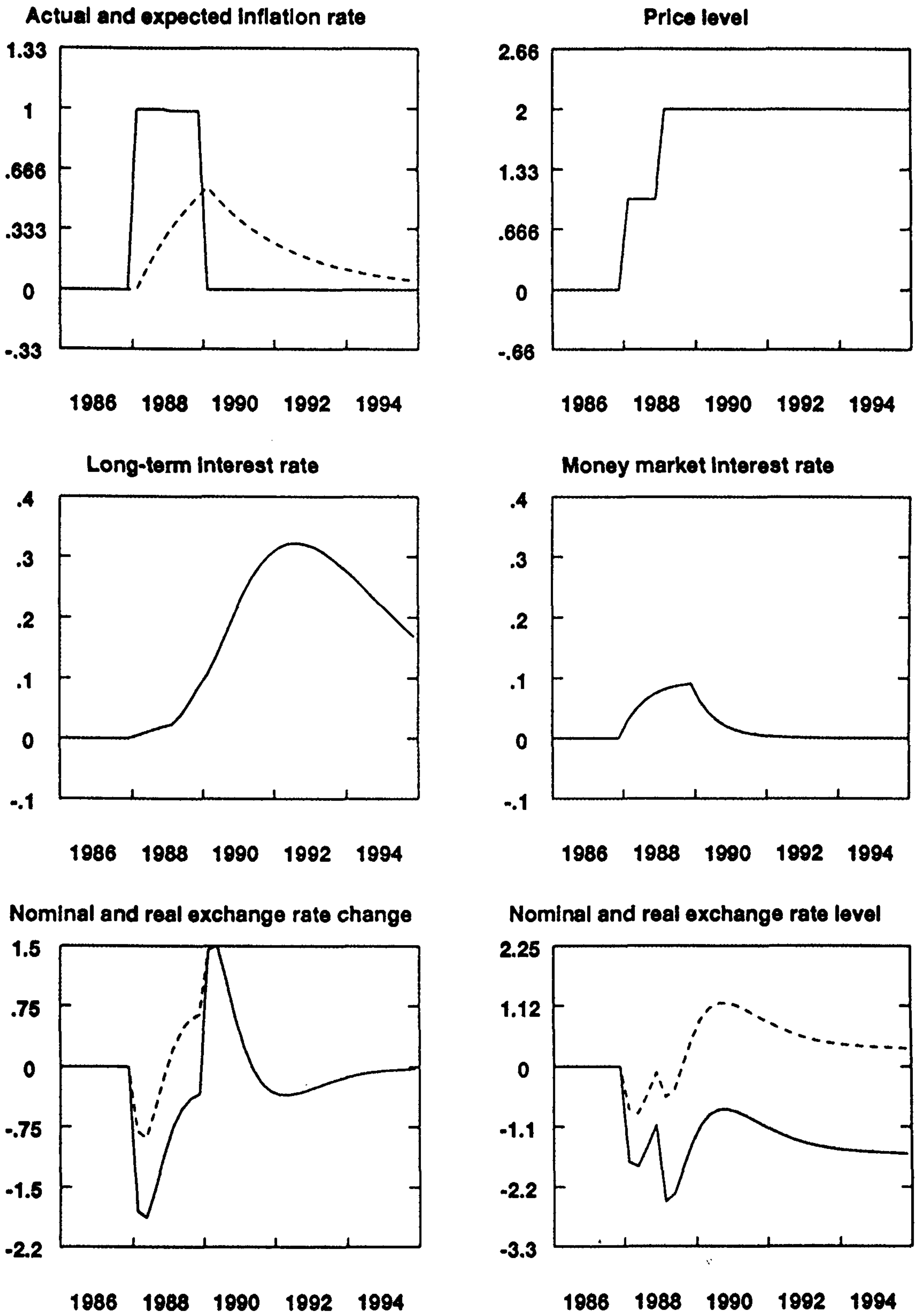

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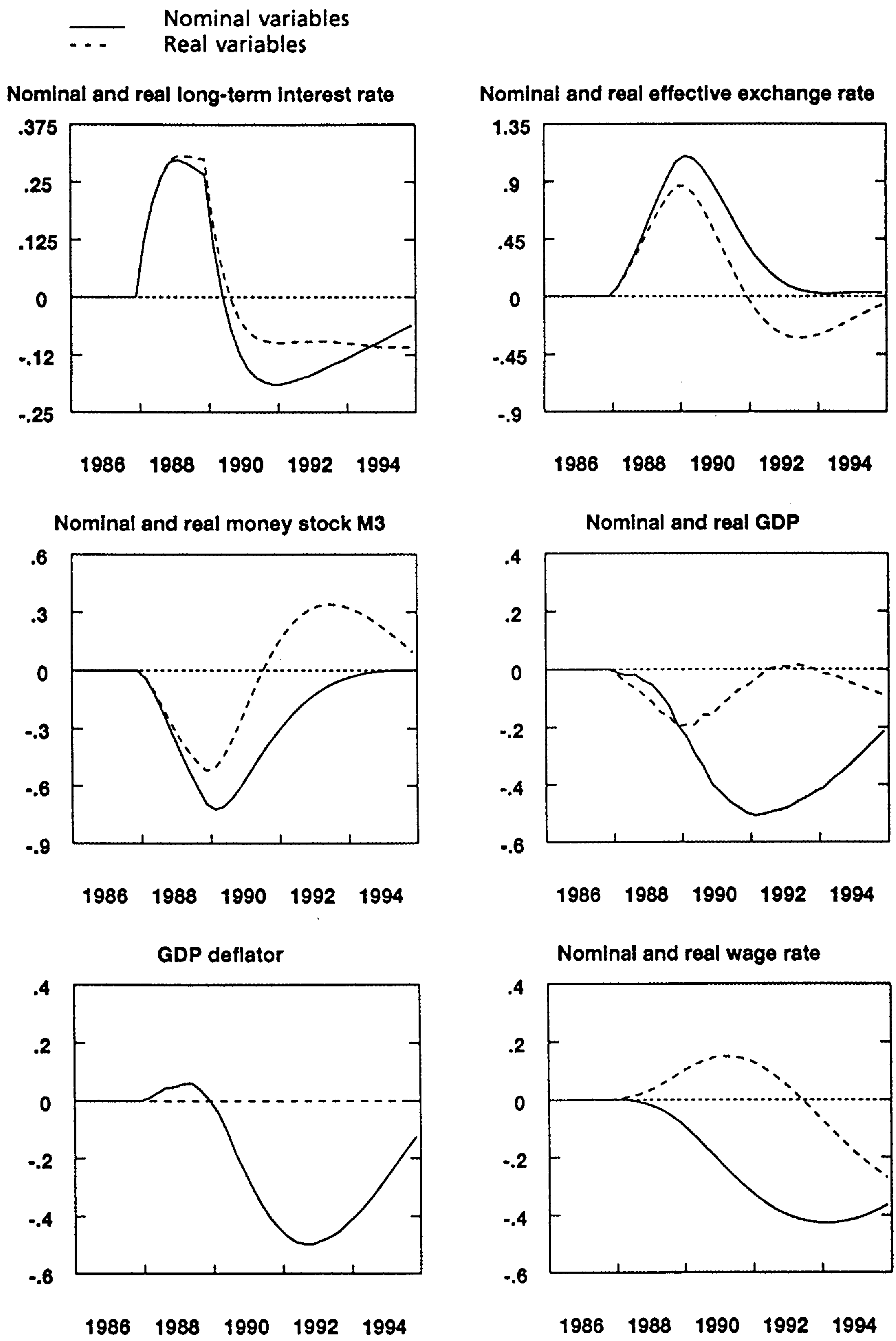
Chart 7

Effects of an increase in Bundesbank interest rates by 100 basis points for two years in the complete model

Deviation from base line in % or in percentage points



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Conclusions

Interest rates and exchange rates are determined in the Bundesbank macroeconometric model of the German economy according to traditional lines using the Fisher equation in explaining the development of long-term interest rates as well as purchasing power parity and uncovered interest rate parity in explaining exchange rates. Moreover, expectation formation is based on adaptive adjustment processes. The empirical relevance of rational expectations seems to be - at least - questionable.[7] Neither in the case of interest rates nor in the case of exchange rates could a firm empirical basis be found in Germany for an integration of intertemporal, i.e. time-consistent stock-flow constraints and their effects on risk premia, into the determination of these asset prices.

7 Even in the new quarterly project model of the Bank of Canada which uses a mixture of adaptive and model-consistent expectations, "considerable weight is in fact put on the backward-looking portion in order to capture the slow adjustment of expectations apparent in economic data". (p. 29). See Poloz, S., D. Rose and R. Tetlow, (1994).

Annex

1. Interest and exchange rate equations in the Bundesbank macroeconometric model of the German economy

1.1 Repurchase rate

a) $RPEN = DIS + GMST * (LOMS - DIS)$

b) $\ln\left(\frac{GMST}{1.25 - GMST}\right) = \underset{(1.39)}{0.24} + \underset{(5.49)}{0.56} \ln\left(\frac{GMST_{-1}}{1.25 - GMST_{-1}}\right) - \underset{(1.68)}{9.51} \sum_{0}^{3} \frac{ZBGD_{-1}}{ZEBA_{-1}} * 0.25$

$\overline{R}^2 = 0.45 \qquad DW = 1.99 \qquad SEE = 1.16$

1.2 Three-month money market interest rate

$$\Delta_1 RGD = \underset{(14.98)}{0.92} \Delta_1 RPEN + \underset{(4.64)}{0.15} \Delta_1 RGDE + \underset{(1.93)}{0.03} * 100 \Delta_4 \ln(PEV)$$

$$+ \underset{(2.88)}{0.31} (RPEN_{-1} - RGD_{-1})$$

$\overline{R}^2 = 0.80 \qquad DW = 2.05 \qquad SEE = 0.35$

1.3 Yield on ten-year government bonds

$$\Delta_4 RFUO = \underset{(2.81)}{0.45} + \underset{(3.22)}{0.87} \Delta_4 DWU_{+2} + \underset{(4.23)}{0.14} \Delta_4 RGD + \underset{(8.96)}{0.62} \Delta_4 RFUO_{-1}$$

$$+ \underset{(3.51)}{0.14} (100 * PEVD_{-4} - RFUO_{-4})$$

$\overline{R}^2 = 0.81 \qquad DW = 0.91 \qquad SEE = 0.49$

1.4 External value of the DM against ERM-currencies

a) $\ln(AUWS) = 3.93 + 1.01 \ln\left(\frac{PEVE}{PEV}\right) - 0.66(RGDE - RGD) * 0.01$

$-0.02Q1 - 0.03Q2 - 0.03Q3 + ECAUWS$

b) $\Delta_4 \ln(AUWS) = \underset{(2.67)}{0.67} \Delta_4 \ln\left(\frac{PEVE}{PEV}\right) - \underset{(2.28)}{0.58} \Delta_4 \ln\left(\frac{PEVE_{-1}}{PEV_{-1}}\right)$

$$+\underset{(9.60)}{0.96}\Delta_4\ln(AUWS_{-1})-\underset{(1.40)}{0.14}\Delta_4\ln(AUWS_{-2})-\underset{(4.34)}{0.24}\sum_{1}^{4}ECAUWS_{-1}*0.25$$

$\overline{R}^2=0.88 \qquad DW=1.75 \qquad SEE=1.29$

1.5 External value of the DM against the US dollar

a) $$\ln(AUUS)=4.27+0.86\ln\left(\frac{PEVU}{PEV}\right)-1.88(RGDE-RGD)*0.01+ECAUUS$$

b) $$\Delta_4\ln(AUUS)=\underset{(3.57)}{3.00}\Delta_4\ln\left(\frac{PEVU}{PEV}\right)-\underset{(3.50)}{2.92}\Delta_4\ln\left(\frac{PEVU_{-1}}{PEV_{-1}}\right)$$

$$-\underset{(1.27)}{0.38}\Delta_4(RGDE-RGD)*0.01+\underset{(9.80)}{1.01}\Delta_4\ln(AUUS_{-1})-\underset{(1.77)}{0.19}\Delta_4\ln(AUUS_{-2})$$

$$-\underset{(1.93)}{0.09}\sum_{1}^{4}ECAUUS_{-1}*0.25$$

$\overline{R}^2=0.81 \qquad DW=1.91 \qquad SEE=5.67$

1.6 External value of the DM against other currencies

a) $$\ln(AUSO)=4.30+0.66\ln\left(\frac{PEVS}{PEV}\right)-0.71(RGDE-RGD)*0.01+ECAUSO$$

b) $$\Delta_4\ln(AUSO)=\underset{(6.38)}{2.44}\Delta_4\ln\left(\frac{PEVS}{PEV}\right)-\underset{(6.11)}{2.77}\Delta_4\ln\left(\frac{PEVS_{-1}}{PEV_{-1}}\right)$$

$$-\underset{(0.19)}{0.03}\Delta_4(RGDE-RGD)*0.01+\underset{(11.66)}{1.00}\Delta_4\ln(AUSO_{-1})-\underset{(2.89)}{0.26}\Delta_4\ln(AUSO_{-2})$$

$$-\underset{(2.61)}{0.17}\sum_{i=1}^{4}ECAUSO_{-1}*0.25$$

$\overline{R}^2=0.84 \qquad DW=1.74 \qquad SEE=2.46$

1.7 External value of the DM against 18 currencies

$$AUDM=AUWS^{0.39794}*AUUS^{0.14151}*AUSO^{0.46055}$$

1.8 Exchange rate of the DM against the US dollar

$$ER=100.633*\frac{3.203}{AUUS}$$

1.9 Price expectations

$$PEVD = 0.9PEVD_{-1} + 0.1\Delta_4 \ln(PEV_{-1})$$

1.10 Price deflator of final demand in 18 industrial countries

$$PEVF = PEVE^{0.39794} * PEVU^{0.14151} * PEVS^{0.46055}$$

1.11 Real external value of the DM against 18 currencies

$$AUDR = AUDM * \frac{PEV}{PEVF}$$

2. List of variables

AUDM External value of the Deutsche Mark against the currencies of 18 industrial countries, end-1972 = 100, Deutsche Bundesbank, Monthly Report, Table X.9, Series WU5879.

AUDR Real external value of the Deutsche Mark, end-1972 = 100.

Defined: $AUDR = AUDM * \frac{PEV}{PEVF}$

AUSO External value of the Deutsche Mark against the currencies of other countries, end-1972 = 100.

Defined: $AUSO = AUDM^{\frac{1}{0.46055}} * AUUS^{\frac{0.14151}{0.46055}} * AUWS^{\frac{0.39794}{0.46055}}$

AUUS External value of the Deutsche Mark against the US dollar, end-1972 = 100, Deutsche Bundesbank, Monthly Report, Table X.9, Series WU5409.

AUWS External value of the Deutsche Mark against currencies of countries participating in the exchange rate mechanism of the European Monetary System, end-1972 = 100, Deutsche Bundesbank, Monthly Report, Table X.9, Series WU5690.

DIS Discount rate of the Deutsche Bundesbank, per cent p.a., Deutsche Bundesbank, Monthly Report, Table VI.1, Series SU0110.

DWU Dummy variable for German unification, from third quarter of 1990 = 1, before = 0.

ER Exchange rate of the Deutsche Mark against the US dollar.

Defined: $ER = 100.633 * \frac{3.203}{AUUS}$

GMST Variable fixing the repurchase rate within the discount/lombard rate band.

Defined: *GMST* = (*RPEN* - *DIS*) / (*LOMS* - *DIS*).

LOMS	Lombard rate resp. special lombard rate of the Deutsche Bundesbank, per cent p. a., Deutsche Bundesbank, Monthly Report, Table VI.1., Series SU0111.
PEV	Price deflator of final demand, 1991 = 100.
PEVD	Price expectations. Defined: $PEVD = 0{,}9 * PEVD_{-1} + 0{,}1 * \Delta_4 \ln(PEV_{-1})$
PEVE	Price deflator of final demand in ERM countries, end-1972 = 100, Series YQD723.
PEVF	Price deflator of final demand in 18 industrial countries, end-1972 = 100, Series YQD720.
PEVS	Price deflator of final demand in other countries, end-1972 = 100. Defined: $PEVS = \dfrac{PEVF^{\frac{1}{0.45055}}}{PEVE^{\frac{0.39794}{0.45055}} * PEVU^{\frac{0.14151}{0.46055}}}$
PEVU	Price deflator of final demand in the United States, end-1972 = 100, Series KA7115.
Q1, Q2, Q3	Seasonal dummy variables for the first, second and third quarter.
RFUO	Yield on government bonds with residual maturities of 9 to 10 years, per cent p.a., Deutsche Bundesbank, *Monthly Report*, Table VII.5, Series WU8612.
RGD	Money market interest rate for three-month funds in Frankfurt am Main, per cent p.a., Deutsche Bundesbank, *Monthly Report*, Table VI.4, Series SU0107.
RGDE	Money market interest rate at the Euro-dollar market for three-month funds, per cent p.a., Deutsche Bundebank, *Monthly Report*, Table VI.7, Series IV1212.
RPEN	Interest rate for Bundesbank's open market transactions in securities under repurchase agreements (repurchase rate), per cent p.a., Deutsche Bundesbank, *Monthly Report*, Table VI.3, Series VQ7225.
ZBGD	Excess reserves of banks, DM bn, Deutsche Bundesbank, *Monthly Report*, Table II.3 and Table V.2, Series AU0715 (unused refinancing facilities) less Series AU0800 (lombard loans) plus Series AU0710 (excess reserves).
ZEBA	Supply of central bank money, DM bn, Deutsche Bundesbank, *Monthly Report*, Table II.3 and Table IV.1, Series AU0024 (central bank money) plus Series OU0313 (cash in hand of credit institutions) plus ZBGD.

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Comments on paper by Dr. Jahnke by P.S. Andersen (BIS)

This is a concise and well written paper which does not leave much for a discussant to add. The presentation of the econometric work is clear and all financial sector equations are supported and illustrated by simulations. Yet, I do have a few comments on each of the three equations presented in the paper.

Long-term bond rate: The structure of the long-term interest rate equation is remarkably simple and transparent, since only the Fisher effect is present. The short-run ECM version is also very simple but I wonder if it might no be too simple:

(i) in Chart 1 the level of the nominal bond rate looks very much like a stationary process, whereas actual and expected rates of inflation are I(1); thus the ECM equation might be misspecified;

(ii) the very low DW statistic might also point to a specification or missing variable problem. Although I have no reason to doubt that Dr. Jahnke carefully tested the influence of foreign bond rates, it is, indeed, surprising that the general trend towards internationally converging bond rates is not confirmed in the German equation;

(iii) when faced with a trend rise in the real bond rate, one always wonders whether this reflects slowly adjusting expectations of inflation or a gradually rising risk premium. Considering the overall economic development of the German economy I share Dr. Jahnke's view that the trend rise is due to highly adaptive expectations. Yet, it might be interesting to see how the equation performs if expectations were taken from surveys or modelled by a Markov switching process as explained in the paper by A. Tarditi.

Short-term interest rate: I found the three-stage explanation of the three-month interest rate very interesting and instructive. However, I "missed" a fourth stage where reactions by the Bundesbank to deviations between actual developments and the target of monetary policy are explained and "fed" into the model.

Exchange rate: I really liked this part of the paper as the three-part equation captures key theoretical arguments (PPP and UIP) while, at the same time, the country disaggregation provides a convincing identification of the sources of the real appreciation of the DM. The variation in parameter size across country groups is also very interesting, and it could well be that the high sensitivity of the DM/US dollar exchange rate to changes in the interest rate differential against US rates provides the "missing link" in the bond rate equation. By contrast, the rather low interest rate sensitivity of the effective value of the DM against other ERM currencies is not "good news" to Germany's main trading partners.