Nontechnical Summary

Do financial market analysts use structural economic models when forecasting exchange rates? This is the leading question analysed in this paper. In contrast to other studies we use expectations data instead of observable variables. Therefore we analyse the implicit structural models forecasters have in mind when forming their exchange rate expectations.

The economic exchange rate models included in our study are purchasing power parity, the flexible-price monetary model, the sticky-price monetary model and the Mundell-Fleming model.

These models are the theoretical basis for the estimation of latent structural models using the categorical expectations data of the ZEW financial market survey. The expectation variables used to explain expected exchange rates are short term interest rates, long term interest rates and business expectations.

Our results show that the flexible-price monetary model is clearly rejected, but the sticky-price monetary model (in case of DM/Pound Sterling and DM/Yen) and the Mundell-Fleming model (in case of DM/US-Dollar) are both compatible with the estimated parameters.

What´s on their Mind: Do Exchange Rate Forecasters Stick to Theoretical Models?

Michael Schröder and Robert Dornau

Centre for European Economic Research (ZEW)

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L 7, 1
P. O. Box 10 34 43
D-68034 Mannheim

Tel.: ++49-621/1235-140
Fax: ++49-621/1235-223
E-mail: schroeder@zew.de

1 Introduction

In the seventies and early eighties monetary exchange rate models have been in the centre of the economic theory of exchange rate behaviour. Since the influential paper of Meese/Rogoff (1983) where the authors show that most structural exchange rate models cannot outperform a simple random walk, the interest in these models has declined, at least in empirical work. Nevertheless monetary exchange rate models still seem to build the basis for the explanation of exchange rate behaviour both in academics and in more popular comments on foreign exchange markets. In this paper we try to analyse what kind of structural models professional analysts have in mind when forecasting exchange rates. Using panel data on expectations for changes in exchange rates, interest rates and the business cycle we estimate different structural economic models to gain insights into the formation of exchange rate expectations. The theoretical approaches used in our study are purchasing power parity, the flexible-price monetary model, the sticky-price monetary model and the Mundell-Fleming model. We employ these approaches to estimate structural models that could explain the expectations for the DM/US-Dollar, DM/Pound Sterling and DM/Yen exchange rates.

The database of the study is the ZEW financial market survey. These data provide us with information on expectations of German financial market analysts. In this study we estimate simultaneous equation systems in latent variables to explain the expectations for exchange rates. The observed categorical data of the survey are used to identify the latent expectations and the structural economic relationships analysts have in mind when forecasting exchange rates.

The results of our estimates show that the flexible-price monetary model is clearly rejected. However the sticky-price model seems to be compatible with the formation of expectations for the DM/Pound Sterling- and the DM/Yen-exchange rate. The expected DM/US-Dollar exchange rate could be explained using the Mundell-Fleming model.

The following chapters are organised as follows: Chapter 2 gives a description of the data. Chapter 3 describes the theoretical exchange rate models as well as the estimation approach. The results of the estimations are presented and interpreted in chapter 4. Chapter 5 concludes.

2 Data

Since December 1991, the Centre for European Economic Research (ZEW) has been conducting a business survey among German financial analysts. Experts of approximately 350 enterprises participate each month, including around 260 banks, 60 insurance companies and 30 industrial companies. Respondents belong to the board, or to the finance, research, asset management or economics department. The respondents are asked to prevail their medium term[1] expectations for important international financial markets with regard to the economic situation, inflation rate, short- and long-term interest rates, stock markets and exchange rates. The countries covered are Germany, USA, Japan, United Kingdom (UK), France, and Italy. The answers given are qualitative assessments of the underlying latent variables using the three categories ”increase”, ”stay approximately the same (no change)” and ”decrease”. In addition a ”don’t know” category can be chosen. For the empirical work the qualitative answers are coded ”decrease” = 1, ”no change” = 2, ”increase” = 3. The ”don’t know” category is dropped. The observation period of each wave is 14 days, but later responses are also included in this study.

This study makes use of the expectations for the gross domestic product (GDP), short- and long-term interest rates and inflation rates of Germany, USA, Japan and UK as well as the relevant exchange rate expectations. The total observation period is December 1991 to December 1997. The resulting 73 waves were pooled. A preselection on the ground of regular or frequent response was not performed. A total of 596 enterprises have participated in the survey. The resulting unbalanced panel consists of about 21.700 observations (depending on the variable analyzed).

Descriptive statistics are given in table 1. A mean of 2 of a categorical variable means that the respondents expected on average no change of the forecasted variable in the future. If the mean is lower than 2 a decrease was expected, while a value above 2 is consistent with an expected increase. The variances of the categorical data are very similar. This is also true for variables such as long term interest rates and exchange rates that in reality have a much higher variance than e.g. inflation rates or GDP.

In addition to the above expectations data, we used differences of expectations between countries for each variable. Differences of expectations are always calculated as Germany minus foreign country. Hence, a positive value means that the difference is increasing. Table 2 shows how the difference variables are computed and table 3 gives the descriptive statistics for the difference variables. Here a mean of zero has to be interpreted as the expectation of no change for the difference variable.

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[1] The respondents are asked for their expectations for the next six months.

Table 1: Descriptive Statistics of Expectations Data

Expectation Variable		No. Obs.	Mean	Std. dev.	Decrease	No Change	Increase
GDP	Germany	22.401	2.31	0.70	14%	41%	45%
	USA	21.926	2.21	0.60	10%	60%	31%
	Japan	21.381	2.40	0.62	7%	45%	48%
	UK	21.417	2.16	0.55	8%	67%	25%
Inflation	Germany	22.380	1.83	0.73	37%	43%	20%
	USA	21.868	2.46	0.56	3%	47%	50%
	Japan	20.953	2.18	0.53	6%	69%	25%
	UK	21.163	2.35	0.63	9%	48%	43%
Short-term interest rates	Germany	22.378	1.66	0.71	48%	38%	14%
	USA	21.869	2.46	0.63	7%	39%	53%
	Japan	21.120	2.10	0.58	12%	65%	23%
	UK	21.171	2.09	0.73	22%	46%	32%
Long-term Interest Rates	Germany	22.385	1.95	0.77	33%	40%	28%
	USA	21.941	2.43	0.66	10%	38%	53%
	Japan	21.103	2.23	0.61	10%	57%	33%
	UK	21.219	2.10	0.71	20%	49%	31%
Exchange Rates	DM/USD	22.139	2.62	0.63	8%	22%	70%
	DM/YE	21.348	1.95	0.72	28%	49%	23%
	DM/UKP	21.582	2.11	0.68	18%	53%	29%

Table 2: Differences of Expectations between Countries: Computation

		Foreign Country: Decrease	No Change	Increase
Germany	Decrease	0	-1	-2
	No Change	1	0	-1
	Increase	2	1	0

Table 3: Differences of Expectations between Countries: Descriptive Statistics

Expectation Variable		No. Obs.	Mean	Std. dev.
GDP	Germany-USA	21892	0.098	0.956
	Germany-Japan	21371	-0.093	0.736
	Germany-UK	21407	0.149	0.858
Inflation	Germany-USA	21830	-0.637	0.852
	Germany-Japan	20938	-0.357	0.751
	Germany-UK	21149	-0.518	0.896
Short-term	Germany-USA	21830	-0.804	0.866
Interest	Germany-Japan	21104	-0.445	0.741
Rates	Germany-UK	21156	-0.437	0.765
Long-term	Germany-USA	21904	-0.483	0.749
Interest	Germany-Japan	21088	-0.283	0.735
Rates	Germany-UK	21203	-0.150	0.738

3 Description of the Theoretical and Empirical Models

Monetary exchange rate models belong to one of the most popular classes of structural models for the explanation of exchange rates. These models try to explain exchange rates using domestic and foreign monetary aggregates, interest rates and economic growth. In our study we want to analyse whether professional financial market analysts employ monetary exchange rate models to forecast future exchange rates. If the analysts believe in the validity of monetary models or at least if they implicitly use these models to formulate their exchange rate forecasts, we should find similar structures in their expectations. In addition, we analyse whether our estimates could be interpreted in the light of the Mundell-Fleming model.

The basis of monetary exchange rate models is the assumption of purchasing power parity:

(1) $$s_t = p_t - p_t^*$$

s_t is the exchange rate (DM price for foreign currency), p_t is the domestic and p_t^* is the foreign price level. All variables are in logs. Equation 1 can be reformulated in expectations i.e. if a forecaster believes that equation 1 is true then the equation should hold in realisations as well as in expectations: $E_t(s_{t+x}) = E_t(p_{t+x}) - E_t(p^*_{t+x})$. Here E_t is the conditional expectations operator which indicates that expectations are formed in period t for the variables *s*, *p* and p^* in period *t+x*.[2] The forecasting horizon is given by *x*.

The monetary exchange rate models usually assume the following money demand functions (* denotes foreign variables):

$$(2)\quad \begin{aligned} m_t^d &= p_t + b \cdot y_t - g \cdot r_t \\ m_t^{d*} &= p_t^* + b^* \cdot y_t^* - g^* \cdot r_t^* \end{aligned}$$

The variable *y* is real income (in logs) and *r* is the nominal interest rate. The money demand functions imply homogeneity of degree one in prices.

Combining equation 1 and the money demand equations and assuming money market equilibrium we get the flexible-price monetary model:[3]

$$(3)\quad s_t = m_t - m_t^* - b \cdot y_t + b^* \cdot y_t^* + g \cdot r_t - g^* \cdot r_t^*$$

$$(3')\quad s_t = (m_t - m_t^*) - b' \cdot (y_t - y_t^*) + g' \cdot (r_t - r_t^*)$$

Here *m* is money supply expressed in logs. In equation 3´ it is assumed that domestic and foreign demand functions have the same coefficients, which is a special case of equation 3.

A basic assumption of the flexible-price monetary model is that changes in the relative supply of monies lead to adjustments of prices and thereby influences the exchange rate. A rise in domestic GDP e. g. will increase money demand and ceteris paribus domestic prices will decline and thus causing an appreciation of the domestic currency (= decrease of s_t). An increase in the domestic interest rate ceteris paribus causes a depreciation because the higher interest rate reduces domestic demand for money.

Dornbusch (1976) suggested a monetary exchange rate model with sluggish price adjustment. The resulting equation of the sticky-price monetary model for the determination of the exchange rate is:[4]

$$(4)\quad s_t = m_t - m_t^* - b \cdot y_t + b^* \cdot y_t^* - d \cdot r_t + d^* \cdot r_t^* + c \cdot inf - c^* \cdot inf_t^*$$

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2 The expectation of future values is conditioned on information known in period t (= I_t). Therefore the expectation operator could be written in detail as $E_t(.) = E_t(. \mid I_t)$.

3 See e.g. Isard (1995), chapter 8, for a description of different monetary exchange rate models.

4 See Isard (1995) for a detailed derivation of the sticky-price monetary model (pp. 134-135)

In the case of identical domestic and foreign money demand functions equation 4. reduces to

(4´) $$s_t = (m_t - m_t^*) - b' \cdot (y_t - y_t^*) - d' \cdot (r_t - r_t^*) + c' \cdot (inf_t - inf_t^*)$$

The flexible-price and the sticky-price monetary models differ in two respects. First, the coefficients of the nominal interest rates in one model have the opposite sign than in the other model. Second, the sticky-price model includes the long term expectations of inflation (*inf, inf**) as additional variables. The long run solution for the exchange rate in the sticky-price model is equal to the flexible-price model, but the sluggish adjustment of prices causes temporary overshooting of the exchange rate compared to the long run equilibrium. The sign and the significance of the coefficients attached to the interest rates and the long term inflation expectations are therefore the major criteria to discriminate between the flexible-price and the sticky-price models.

To test the theoretical models we estimate equations 4 and 4´ using the ZEW expectations data. Due to the non-stationarity of the variables, equations 4 and 4´ are usually estimated in differences when observable data are used. In our case of expectations data the variables are in differences by construction. In the survey we ask for the expected future change of the variables. Therefore, and due to the categorical nature of the data the series are stationary and can be directly used for econometric estimations.

In the estimation we use domestic and foreign business expectations as proxies for y_t and y_t^*. The business expectations behave very similar to future growth of GDP and can therefore be used as a proxy for the real income variable in the estimation models. The effects of the nominal interest rates (r_t, r_t^*) on the exchange rate is usually estimated using short term interest rates. The use of short term interest rates is due to the interpretation of monetary models as equilibrium models for the money market. In our empirical analysis we therefore also employ expectations for future short term interest rates to estimate the interest rate effect on exchange rates.

In most empirical studies long term inflation expectations (inf_t, inf_t^*) are proxied by long term interest rates, since assuming rational expectations long term interest rates should capture the bond market expectations of future inflation. In our study we also choose the expectations for long term interest rates as a proxy for expected long term inflation. Respondents to the ZEW survey prevail their medium term inflation expectations. Hence, this variable will not capture the expected long term trend of inflation.[5] However expectations for long term interest rates of the ZEW survey

[5] A direct estimation of equation 1 using the expectations for inflation from the ZEW survey resulted in coefficients with signs opposite to the theoretical model for all three currencies. The coefficient for

could be a good proxy for long term inflation, because the respondents should take into account their expectations for inflation in the more distant future when forecasting long term interest rates.

In the theoretical models (equations 3, 3´, 4 and 4´) monetary supply is an important variable for the exchange rate determination. Unfortunately the ZEW survey does not cover the expectations for future changes in money supply. Therefore the effect of this variable cannot be taken into account in the estimation.[6] In addition to the two described monetary models we also test whether a Mundell-Fleming type model is compatible with the data. Assuming equilibrium in the balance of payments and high capital mobility an increase in domestic GDP causes a surplus in the current account and thereby an appreciation of the currency. Therefore, in this case the coefficients for GDP in the monetary models and the Mundell-Fleming model have the same signs. In the Mundell-Fleming model, an increase in domestic short and long term interest rates causes capital inflows and hence an appreciation of the currency. While the coefficients of the short term interest rates have the same sign in the sticky-price model and the Mundell-Fleming model, the coefficients of the long term interest rates have the opposite sign.

The resulting specifications of the estimation equations for the exchange rates in terms of the variables of the ZEW survey are:

(5) $$s_t = \beta \cdot y_t + \beta^* \cdot y_t^* + \delta \cdot rs_t + \delta^* \cdot rs_t^* + \lambda \cdot rl_t + \lambda^* \cdot rl_t^*$$

(5´) $$s_t = \beta \cdot (y_t - y_t^*) + \delta \cdot (rs_t - rs_t^*) + \lambda \cdot (rl_t - rl_t^*),$$

where y_t are the expectations of future GDP growth, rs_t is the expected short term interest rate and rl_t the expected long term interest rate.

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domestic inflation has for all three currencies a negative sign and the coefficient of foreign inflation a positive sign and both are all highly significant. The wrong signs should be attributable to the short horizon of the inflation expectations. Therefore inflation expectations are rather a proxy for expected future changes in short term interest rates than an indicator for the expected long term trend of inflation. An indication for this assumption is that the coefficients of short term interest rates all have the same sign as the corresponding coefficients of inflation. In addition the expectations for inflation and short term interest rates are highly correlated with a polychoric correlation of about 0.5 for all four countries included in our study.

[6] Money supply has not been included in the monthly survey because of severe problems concerning the usefulness of money supply expectations. Money supply would be in most cases expected to increase in the next 6 months. Therefore, a categorical variable „expected future change in money supply“ would have nearly no variance and could not be used for statistical inference. As a consequence we expect that the neglect of this variable should have no major impact on the quality of the estimations of the other coefficients.

Using equation 5 to test for the three theoretical models the estimated coefficients should reveal the following signs (table 4):

Table 4: The Coefficients of the Parameters in the Structural Models

	β	β^*	δ	δ^*	λ	λ^*
Flexible-Price Monetary Model	-	+	+	-	0	0
Sticky-Price Monetary Model	-	+	-	+	+	-
Mundell-Fleming Model	-	+	-	+	-	+

Equation 6 shows the general structure of the estimation model. *Y** is the vector of the (latent) endogenous variables, *X* represents the matrix of the exogenous variables, *K*, *B* and *P* are the matrices of the coefficients and ε is the vector of the disturbance terms.

(6) $$Y^* = K + B \cdot Y^* + P \cdot X + \varepsilon$$

The elements of *Y** are (latent) expectations variables that can be identified from the survey data. Matrix *B* contains the simultaneous effects between the expectations variables. In case of equation 5 *B* is a 9x9-matrix, while in case of the identical domestic and foreign money demand functions (equation 5´) *B* has the dimension 5x5.[7] Table 5 shows the elements of the 9x9-Matrix. According to equation 5 we assume that expectations for short and long term interest rates and GDP expectations contribute to the explanation of the exchange rate (= first row of table 5: *b1, b3, b9, b12, b15, b17*). The subsequent rows of table 5 show the assumed simultaneous relationships between the explanatory variables. These relationships are equal for all countries and have the following properties: expected GDP growth influences expected inflation (*b2, b4*) and expected inflation has impacts on short- and long term interest rate expectations (*b5 - b8*). It is assumed that short term interest rates will influence long term interest rates (*b11, b14*) and both can effect growth expectations (*b10, b13, b16, b18*). The signs and the significance levels of the coefficients of the exchange rate equation allow a discrimination between the different structural exchange rate models according to table 4.

In addition we also estimate equation 5´ assuming equal money demand functions. In this case we employ the same relationships between the expectation variables in a

[7] In Matrix *B* the expectations for domestic and foreign inflation are included in addition to the variables of the theoretical model (equation 4). The reason is that expectations for inflation are highly correlated with the expectations for short and long term interest rates. The inclusion of inflation expectations might therefore improve the estimation of the whole system.

5x5-dimensional Matrix *B*, but with all variables expressed in differences between corresponding domestic and foreign items.

Table 5: Simultaneous Effects (Matrix *B*) in Case of Different Domestic and Foreign Money Demand Functions

	s	gdp	gdp*	p	p*	rs	rs*	rl	rl*
Exchange rate (s)	0	**b1**	**b3**	0	0	**b9**	**b12**	**b15**	**b17**
Domestic business expectations (gdp)	0	0	0	0	0	**b10**	0	**b16**	0
Foreign business expectations (gdp*)	0	0	0	0	0	0	**b13**	0	**b18**
Domestic inflation (p)	0	**b2**	0	0	0	0	0	0	0
Foreign inflation (p*)	0	0	**b4**	0	0	0	0	0	0
Domestic short term interest rates (rs)	0	0	0	**b5**	0	0	0	0	0
Foreign short term interest rates (rs*)	0	0	0	0	**b7**	0	0	0	0
Domestic long term interest rates (rl)	0	0	0	**b6**	0	**b11**	0	0	0
Foreign long term interest rates (rl*)	0	0	0	0	**b8**	0	**b14**	0	0

Matrix *B* is estimated together with matrix *P* which contains the coefficients of the exogenous variables *X*. As we use pooled data (across time and respondents) we assume that the structure of the model (= matrix *B*) is constant over time and that the respondents are all equal. This means that the estimated model shows the structure between the variables as an average of all respondents.

In our study the only exogenous variables are time dummies i.e. we define one dummy variable for each point in time ($d_i = 1$ if $i = t$ and $d_i = 0$ otherwise, $i,t = 1,...,72$). These dummy variables capture the effect of exogenous influences on the intercept that are common to all respondents e.g. a shift in the level of expectations due to a change in economic policy at time *t*. The dummy variables are represented by matrix *X*.

All estimations have been carried out using the econometric software package MECOSA.[8] In equation 6 the vector *Y** contains the latent expectations. The latent expectations *Y** are continuous variables that represent the true but unknown expectations of the respondents of the ZEW survey. The relation between the latent expectations and the observed ordered categorical variable Y is controlled by the two thresholds α_1 and α_2:

$$
(7) \qquad \begin{array}{rcl} Y_t^* \geq \alpha_2 & : & Y_t = 3 \\ \alpha_1 \leq Y_t^* \leq \alpha_2 & : & Y_t = 2 \\ Y_t^* < \alpha_1 & : & Y_t = 1 \end{array}
$$

The thresholds have to be estimated together with the coefficient matrices *B* and *P*. A basic assumption of the estimation procedure is that the residuals ε are normally distributed with mean zero and variance-covariance matrix Ω: $\varepsilon \approx N(0,\Omega)$. The estimation procedure of MECOSA has three steps: in the first step the thresholds are estimated together with the reduced form coefficients and the reduced form error variances for each equation by maximum likelihood.[9] The estimated equations in the first step are therefore: $Y^* = (I-B)^{-1}\cdot K + (I-B)^{-1}\cdot P\cdot X + (I-B)^{-1}\cdot\varepsilon$.

In step 2 the program estimates the reduced form covariances $(I-B)^{-1}\cdot\Omega\cdot(I-B)'^{-1}$. In our case of only qualitative variables the variances are restricted to be one. This is a necessary condition for identification. The covariances are therefore the polychoric correlations between the categorical variables.[10] Step 2 is also estimated by maximum likelihood.

In step 3 the structural parameters of equation 6 (*K, B, P* and Ω) are estimated by a minimum distance approach.

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8 MECOSA is the abbreviation of MEan and COvariance Structure Analysis. The programme is based on the econometric software GAUSS. For a description of the programme and the estimation procedures see the manual of MECOSA (Arminger/Wittenberg/Schepers (1996)) and e. g. Sobel/Arminger (1992) or Arminger/Ronning (1991).

9 In the estimation the lower threshold α_1 is set to zero, while a constant and the upper threshold α_2 are estimated for each latent variable. An alternative restriction would be to estimate both thresholds but to exclude the constant. One of these restrictions has to be chosen for identification of the parameters. The resulting estimations of the coefficient matrices *B*, *P* and *Ω* are not influenced by the choice of the identification restriction.

10 For more information on the concept of polychoric correlations and their estimations see e. g. Poon/Lee (1987).

4 Estimation Results

Tables 6 and 7 show the results of the estimations for the structural exchange rate equations.[11] The estimated coefficients of matrix *B* give the relationships between the latent expected variables.[12] Therefore they should be interpreted as answering the question „What is the influence of the (latent) expectations of e.g. domestic short term interest rates on the (latent) expectation on the exchange rate?“. The coefficients of the exchange rate equation show the impact of the theoretically relevant economic variables on exchange rates in the mind of the respondents. However, the coefficients of the same fundamental variable for different equations cannot be compared directly since the coefficients are only identified up to a scale factor i. e. the coefficients are estimated as ratio $b_i = (\beta_i / \sigma_i)$, where σ_i is the standard deviation of the reduced form standard error of equation *i*. Because σ_i is not estimated but set to one, β_i is not identified. Therefore, in tables 6 and 7 only the coefficients in the same column should be compared.

First, we discuss the results for the exchange rate equations when the money demand functions are assumed to be equal (table 6).

Table 6: Results of the Exchange Rate Equation (First Row of Matrix *B*)

$$s_t = \beta \cdot (y_t - y_t^*) + \delta \cdot (rs_t - rs_t^*) + \lambda \cdot (rl - rl_t^*) + u_t$$

	DM/US-Dollar	DM/Pound Sterling	DM/Yen
GDP (y - y*)	-0.0906***	-0.0884***	-0.0573***
Short term interest rates (rs - rs*)	-0.0917***	-0.0469***	-0.0268***
Long term interest rates (rl - rl*)	-0.0864***	0.0147	0.0211***

Significance levels of one-sided tests: *** = 1%, ** = 5%, * = 10%

In this case we estimate the model using the differences between domestic and foreign variables. The coefficients for GDP expectations show the theoretically assumed signs. This means that an increase in the expected GDP difference causes the expectation of an appreciation of the DM against US-Dollar, Pound Sterling or Yen. The signs of the short term interest rate difference are all fully in line with

[11] We estimate the equations for the period December 1991 until December 1997. Each pooled data series has approximately 20.000 data points. See chapter 2 of this study for detailed information on the data.

[12] We do not report the results for the time dummies (X) in detail. Wald tests have shown that for each equation the null hypothesis that all time dummies are zero can be rejected at the 1% significance level.

either the sticky-price model or the Mundell-Fleming model. An increase in the interest rate difference i.e. an increase in German interest rates or a decline of foreign interest rates leads to a stronger DM. Explaining changes in exchange rates by changes in interest rates is probably one of the most popular approaches . Usually it is assumed that an increase in domestic interest rates induces capital flows and thereby appreciates the domestic currency. This popular view is also in line with both the sticky-price model and the Mundell-Fleming model.

The coefficients of the long term interest rate difference show whether purchasing power parity is expected to hold in the long run. In our estimation models (equations 5 and 5´) the expected long term interest rates are proxies for long term inflation. An increase in the long term interest rate differential therefore means that the financial analysts expect a relatively higher domestic inflation in the long run. This is the interpretation compatible with the sticky-price monetary model.

In the Mundell-Fleming model the coefficients for short and long term interest rates should have the same sign, indicating that e.g. higher interest rates lead to capital inflows that appreciate the currency.

Only for DM/Yen the coefficient for the long term interest rate differential is significant and has the correct sign in terms of purchasing power parity (PPP). Expected long term interest rates have no significant impact on the expected DM/Pound Sterling rate, although the sign is as assumed by PPP. For the US-Dollar the coefficient is significant but has the opposite sign compared to PPP.

Combined with the results for GDP and short term interest rates the expectations on the US-Dollar are consistent with the Mundell-Fleming model while the sticky-price model seems to be more appropriate for DM/Pound Sterling and DM/Yen.

Table 7 shows the results for the case that domestic and foreign money demand functions are not equal. In this case we do not impose the equality restrictions on the coefficients. Wald tests show that the equality restrictions are rejected at the 1% significance level for all pairs of coefficients except the coefficients of the short term interest rates in the DM/US-Dollar equation.

The estimation results in table 7 give additional insights into the relationships between the latent expectation variables. It can be seen that in some cases only the domestic or the foreign variable is significantly different from zero. However, the estimates confirm the results of the former estimates with all variables in differences (table 6).

Table 7: Results of the Exchange Rate Equation (First Row of Matrix *B*)

$$s_t = \beta \cdot y_t + \beta^* \cdot y_t^* + \delta \cdot rs_t + \delta^* \cdot rs_t^* + \lambda \cdot rl_t + \lambda^* \cdot rl_t^* + u_t$$

	DM/US-Dollar	DM/Pound Sterling	DM/Yen
Domestic GDP (y)	-0.0012	-0.0192**	-0.0278***
Foreign GDP (y*)	0.1788***	0.1351***	0.0792***
Domestic short term interest rates (rs)	-0.0944***	-0.0146	-0.0011
Foreign short term interest rates (rs*)	0.1018***	0.0599***	0.0479***
Domestic long term interest rates (rl)	-0.064***	0.0071	0.0243***
Foreign long term interest rates (rl*)	0.0371***	-0.027***	-0.0021

Significance levels of one-sided tests: *** = 1%, ** = 5%, * = 10%

The estimated structural relationships for DM/Pound Sterling and DM/Yen are compatible with the sticky-price monetary model and both therefore contradict the flexible-price monetary model and the Mundell-Fleming model. But for the DM/US-Dollar equation the Mundell-Fleming model is better suited to the data than the sticky-price model. In any case it can be concluded that the flexible-price monetary model is clearly rejected by the estimates of all three exchange rate equations.

Another interesting result of the estimates presented in tables 6 and 7 is the dominance of the GDP expectations. Especially the expected foreign GDP has the strongest influence on the exchange rate in all three exchange rate equations. Hence the respondents believe that a change in foreign GDP is the most important fundamental factor for the future exchange rate development.

5 Conclusions

In this study we have analysed the relationships between important fundamental variables (short and long term interest rates, GDP) and the exchange rates DM/US-Dollar, DM/Pound Sterling and DM/Yen. In contrast to other studies we made use of expextations data instead of realisation of the relevant variables. Therefore, the focus of our study is on the latent structural equations the respondents of the ZEW survey might have in mind when forecasting future exchange rates. The economic hypotheses tested in this study are whether popular structural models could be compatible with the estimation results. The alternative models included in this study are the flexible-price monetary model, the sticky-price monetary model and the Mundell-Fleming model. The results of the parameter estimates reject clearly the flexible-price model for all three currencies. While the sticky-price monetary model holds in the expectations for DM/Pound Sterling and DM/Yen, the estimates for the DM/US-Dollar exchange rate are compatible with the Mundell-Fleming model.

6 References

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