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Topically Orientated Trend Adjustment and Autocorrelation of the Residuals

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Topically Orientated Trend Adjustment and Autocorrelation of the Residuals

An Empirical Investigation of the Forecasting Behavior of Bond Market Analysts in Germany between 1989 and 2007

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Abstract. The analysis of 17,880 interest rate forecasts in the German money and capital market shows that all 116 forecast time series analysed are biased. The bias is particularly due to an autocorrelation of the residuals, which is the immediate consequence of the topically orientated trend adjustment of the forecasts. The efforts of the analysts thus lead to systematically biased forecasts, because they allow themselves to be too strongly influenced by the current market situation when making their forecasts. Alongside tests for unbiasedness, efficiency tests and sign accuracy tests, comparisons with naïve forecasts and with simple ARIMA models are carried out.

JEL classification: E47, G12, G21.

Keywords: Forecasting behavior; bond market analysts; unbiasedness test, forecast accuracy, German banks

1. INTRODUCTION

The test for unbiasedness is one of the best-established procedures for characterising and evaluating forecasting data. Pairs of variates are formed from the forecasts and the actual events. A regression line is then estimated for these pairs of variates. A forecast time series is considered unbiased as long as the increase of the regression line does not significantly deviate from 1, and at the same time the intercept does not significantly deviate from 0, and if the residuals are independently distributed.

The examination of the residuals is at the heart of this analysis. On the basis of short and medium-term interest rate forecasts for the German money and capital markets, it is shown that the characteristic of topically orientated trend adjustment in forecast time series always leads to residuals which are not independently distributed, but have systematic components.

The data basis of the analysis is explained in the second chapter. In the third chapter, the results of the tests for unbiasedness are presented. Topically orientated trend adjustments are identified as the cause of biasedness in the fourth chapter. In order to achieve a comprehensive evaluation of the forecasts observed, the results of further procedures for the evaluation of forecasts (sign accuracy tests, efficiency tests, comparisons to naïve forecasts and to simple ARIMA models) are presented in the fifth chapter. A summary of the research results as well as the conclusion follows in the sixth chapter.

2. DATA

The study is based on the interest rate forecasts for the German money and capital markets which were published in the period between October 1989 and October 2006 in the journal Consensus Forecasts. The forecasts have forecast horizons of four or 13 months.[1] The observation period extended from January 1990 to January 2007.

The forecasts refer to the 3-month Euro (DEM) interest rate and to the 10-year German Government bond yield. The forecasts are from German and international banks as well as from a number of research institutes. They were recorded and published on a monthly basis.

The 116 forecast time series contain 17,880 items of data. The shortest examined time series is 39 forecast data, the longest 203 forecast data. On average each of the 116 time series provides 154 forecast data.

[1] Consensus Forecasts distinguishes between two forecast horizons: three and twelve months. In practical terms, however, the forecast horizons are of four and 13 months. This can be clarified by an example: In the Consensus Forecasts Magazine of September 2001, which comes out in the middle of the month, forecasts for the end of December 2001 and for the end of September 2002 are published. The published forecasts were compiled at the beginning of September at the participating institutions. From the beginning of September to the end of December is actually four months, and from the beginning of September of the year in question to the end of September of the following year is actually 13 months.

3. TEST FOR UNBIASEDNESS

The test for unbiasedness examines whether the forecasts correspond to the actual events which take place later on. x_t represents the actual event at the moment in time t, $\hat{x}_t$ represents the forecast of this event, and u_t a residual at the moment in time t.

$$x_t = a + b\ \hat{x}_t + u_t \tag{1}$$

If this relationship is created between the forecast data and corresponding actual events, the following picture arises: It can be stated that the forecasts are unbiased if a does not significantly differ from 0 and b does not significantly differ from 1, and in addition if the error term u is not autocorrelated. The former is verified with the aid of the F-test and the latter by using the Durbin-Watson test. All standard errors are calculated applying the Newey and West (1987) estimation procedure that allows for heteroscedasticity in the error terms. This is indispensable when the forecast horizon is larger than the observational frequency (see Hanson and Hodrick, 1980).

The results of the unbiasedness test are sobering. In all 58 forecast time series on the 10-year German Government Bond yield, the F-test shows that a is significantly different from 0 and/or that b is significantly different from 1 (Tables 1-2). In the forecasts of the 3-month Euro (DEM) interest rate with a forecast horizon of 13 months, the same findings occur in 27 of the 29 forecast time series (Table 3). The situation only appears more favourable in the case of the forecasts of 3-month Euro (DEM) interest rates with a forecast horizon of four months. Only eight out of 29 forecast time series are already shown to be biased by the F-test (Table 4).

INSERT TABLES 1-4

In the end, however, not a single one of the 126 forecast time series observed proves to be unbiased. This is particularly due to the fact that the residuals u_t are not distributed independently, but are in fact autocorrelated (Tables 1-4). This indicates the presence of systematic components which are not recorded by the forecasts. The forecasting approaches used therefore have to be viewed as misspecifications. They do not adequately reflect the actual situation on the money and capital markets. In view of the very high significance – without exception – of all of the results in the Durbin-Watson test, the question of the reasons for the autocorrelation arises. The fourth chapter deals with this question.

4. TEST FOR TOPICALLY ORIENTATED TREND ADJUSTMENT

The circumstance that residuals are not independently distributed can have a variety of reasons. This chapter shows that, if it is present, a topically orientated trend adjustment is usually one of these reasons. As topically orientated trend adjustments very often occur in financial market forecasts,[2] this aspect takes up a central position here.

When forecasts are mainly shaped by the current trend of the variable to be forecast, so that the forecasts correspond to a greater extent with actual events at the time when forecasts were issued than with those at their respective point of time of validity, this is labeled as topically orientated trend adjustment behavior of forecasts (TOTA).

[2] Since Andres and Spiwoks (1999) various studies, e.g. Spiwoks (2003, 2004) or Bofinger and Schmidt (2003, 2004), have furnished proof of its existence for interest rate forecast time series as well as for stock index and exchange rate forecast time series. It equally occurs for forecasts with various forecast horizons (1, 3, 6, 12, and 24 months).

The TOTA coefficient can be used to identify this characteristic. To calculate the TOTA coefficient (see Andres and Spiwoks, 1999; Bofinger and Schmidt, 2003), firstly the coefficient of determination of the forecast data and the actual events are calculated (R^2_A). Then the coefficient of determination of the forecast data from the time when forecasts were issued with the actual events is calculated (R^2_B).

$$\text{TOTA coefficient} = \frac{R^2_A}{R^2_B} = \frac{R^2_{\text{forecasts; actual}}}{R^2_{\text{forecasts; actual - } h}} \qquad (2)$$

With h: Forecast horizon

If the value of the TOTA coefficient is < 1, a topically orientated trend adjustment must be assumed. In this case the forecast time series reflects the present more strongly than the future.

INSERT TABLE 5

Topically orientated trend adjustments are apparent in all of the 116 forecast time series observed without exception (Table 5). This means that the forecast time series reflect the actual development of interest rates at the time when the forecast was made more strongly than the rates at the time the forecast applied to. If there is a topically orientated trend adjustment, the forecast time series is essentially a delayed reflection of the real development of interest rates. If the interest rate trend is downwards, there will be a persistent overestimation of the interest rate level. If the interest rate trend is rising, however, there will be a persistent underestimation of the interest rate level (see diagrams 1 and 3).

INSERT DIAGRAMS 1-4

For the residuals (bottom third of the diagrams 1 and 3), it makes no difference whether one observes the interest rate forecasts and the actual interest rate trend (top third of the diagrams 1 and 3), or whether one observes the forecast interest rate changes and the actual changes (middle third of the diagrams 1 and 3), as the following equation applies:

$$RA_t = F_t - E_t = F_t - E_{t-h} - E_t + E_{t-h} = (F_t - E_{t-h}) - (E_t - E_{t-h}) = RD_t \qquad (3)$$

where:

F_t = forecast for the moment in time t

E_t = actual event at the moment in time t

h = forecast horizon

E_{t-h} = actual event at the moment in time when the forecast is made

RA_t = $F_t - E_t$ = residual of the forecast and the actual event at the moment in time t

$F_t - E_{t-h}$ = forecast change

$E_t - E_{t-h}$ = actual change

RD_t = $(F_t - E_{t-h}) - (E_t - E_{t-h})$ = residual of forecast change and actual change at the moment in time t

On the other hand, it is surprising that the courses of the residuals only vary negligibly, depending on whether one starts out from the original data (yield in percent and forecast yield in percent) or from the result of the regression analysis on the basis of the original data or from the result of the regression analysis on the basis of the rates of change (actual and forecast change in the yield in percentage points) – see diagrams 2 and 4. The scatter plots in the forecast-realisation diagram differ significantly in part, but the typical course of the residuals for topically orientated trend adjustments is largely preserved: due to the delayed adjustment of the forecasts there are sustained phases of over- and underestimation of the subject of the forecast with the consequence that the residuals move in long sweeps: sometimes there are 20, 30 or 40 positive residuals in succession, then there are

20, 30 or 40 negative residuals in succession. One can see at first glance that the residuals are by no means distributed independently, but that they are highly autocorrelated.

All 116 forecast time series are characterised by the fact that they trace the actual interest rate development with a time delay (with only insignificant individual variations). Accordingly, they all exhibit a topically orientated trend adjustment, which in turn automatically leads to autocorrelations of the residuals. There is thus a direct link between the characteristic of topically orientated trend adjustment of the forecast time series and their biasedness.

These findings remain the same regardless of which characteristic of the residuals is observed: (a) The deviations between actual and forecast interest rates (b) The deviations between actual and forecast changes of the interest rates (c) The deviations from the regression line estimated in the forecast-realisation diagram (on the basis of actual and forecast interest rates) or (d) The deviations from the regression line estimated in the forecast-realisation diagram (on the basis of actual and forecast changes in the interest rates). There is therefore a very robust link between topically orientated trend adjustment and autocorrelated residuals. As time series of financial market forecasts normally exhibit the characteristic of topically orientated trend adjustment, the residuals are mostly autocorrelated and the forecast time series are thus biased.

Overlapping forecasts often lead to residuals which are not independently distributed. However, if the phenomenon of topically orientated trend adjustment is present, the problem becomes that much more severe. In that case, the periods in which there are longer lasting over- or underestimations are no longer determined by the forecast horizon. Instead, the duration of the movement of the market in one direction is the decisive factor.

INSERT DIAGRAMS 5-6

This is easily recognisable in the examples of 10-year German Government bond yield forecasts with a forecast horizon of 13 months and the 3-month Euro (DEM) interest rate forecasts with a forecast horizon of four months. The forecasting errors are a mirror image of the actual interest rate trend. As long as there is a rising (falling) interest rate trend, there are underestimations (overestimations). The duration of the underestimations and overestimations is not determined by the forecast horizon, but by the duration of the market trend. The development of the forecasting errors is therefore dominated by the phenomenon of topically orientated trend adjustment.

INSERT TABLE 6

In Table 6, the consensus forecasts for the four forecast subjects are analyzed on behalf of all the forecast time series. The forecast errors exhibit correlations of between -0.79 and -0.89 with the actual changes of the level of interest rates. From 62% to 79% of the variance in forecasting errors can thus be explained by topically orientated trend adjustment behavior. We therefore consider it inadmissible to attribute the bias of the residuals solely to the overlapping forecast horizons.

5. FURTHER EVALUATION OF THE INTEREST RATE FORECASTS

The correlation between topically orientated trend adjustment and the biasedness of forecasts is the main focus of this study. However, this does not mean refraining from the evaluation of the interest rate forecasts with the aid of other means of assessment. This is why we carried out efficiency tests and sign accuracy tests. In addition, comparisons were made with naïve forecasts as well as with simple ARIMA models.

The test for efficiency examines whether appropriate consideration has been given to the actual events which can be observed before the issue of a forecast. x_t represents the actual event at the moment in time t, $\hat{x}_t$ represents the forecast of this event, h the forecast horizonn and u_t a residual at the moment in time t.

$$x_t - \hat{x}_t = b_0 + \sum_{i=1}^{4} b_i \, x_{t-h-i} + u_t \tag{4}$$

If the available information has been used efficiently, the analysts' forecast errors should not be correlated with the lags. Following the example of Simon (1989), we take the last four actual events into consideration. Whether an existing correlation between the forecast errors and the lag variables can be viewed as significant is determined with the aid of the F-test.

Sign accuracy is measured by comparing the forecasts with the actual events and then arranging them in a 2x2 contingency table. The forecasts which estimated the direction of development of interest rates correctly (rising or falling) can be found in the main diagonals (N_{11} and N_{22}). The off-diagonals (N_{12} and N_{21}) contain the forecasts which wrongly estimated the direction of the interest rate change. An χ^2 test is now applied to examine whether the distribution frequency of the four fields is significantly different from a ran-

dom walk forecast (cf. Diebold and Lopez, 1996; Joutz and Stekler, 2000). If this is the case, it is necessary to determine whether the forecasts examined were significantly better or significantly worse than a random walk forecast.

Finally, the forecasts are assessed using two standards of comparison. Comparisons with naïve forecasts as well as with simple ARIMA models are made.

Let us assume that a black box generates a quantifiable event in regular time intervals. We can observe the time series of these events, but we have no insight whatsoever into the processes occurring inside the black box, and how the visible results were generated. Let us also assume that despite our complete ignorance we have to make a forecast on the future tendency of the time series. As we have no information on the genesis of events, both the future increasing and decreasing course of the time series are equally probable. Thus it seems sensible to assume an unchanged situation in the future (naïve forecast). This idea goes back to the French mathematician Pierre Simon Laplace (1814), who introduced it into the literature as the "principle of insufficient reason". Since then the naïve forecast has been judged as the rock-bottom of forecast quality. Even if nothing is known about the forecast subject, the forecast quality of a naïve forecast can be achieved without effort. If a market expert at least roughly understands the processes to be forecast, his forecasts should have a better quality than naïve forecasts.

Henri Theil (1955, 1966, 1971) used this assumption to develop forecast error measures which allow an implicit comparison of a forecast time series with the time series of the respective naïve forecast. In particular, Theil's new inequality coefficient (Theil's U_2) has been generally accepted.

$$U_2 = \frac{\sqrt{\frac{1}{T-h}\sum_{t=h+1}^{T}(P_t - A_t)^2}}{\sqrt{\frac{1}{T-h}\sum_{t=h+1}^{T}(A_t)^2}} \tag{5}$$

$$P_t = \frac{\hat{x}_t - x_{t-h}}{x_{t-h}} \tag{6}$$

$$A_t = \frac{x_t - x_{t-h}}{x_{t-h}} \tag{7}$$

with

t	=	Continuous time index
T	=	Total amount of present forecasts or actually occurred events
x_t	=	Occurred event at point of time t (t from t = 1 to T)
$\hat{x}_t$	=	Present forecast at point of time t (t from t = 1 to T)
h	=	Forecast horizon
x_{t-h}	=	Occurred event at point of time t-h (point of origin of forecast)

For a perfect forecast, $U_2 = 0$. If $U_2 = 1$ the reviewed forecast time series is, on average, as bad as the time series of naïve forecasts. For $U_2 > 1$ the applied forecasting procedure is even worse than naïve forecasting. A forecast time series which is better than the time series of naïve forecasts will result in $U_2 < 1$.

In addition, it is established whether the performance of the analyzed forecast time series goes significantly beyond a simple ARIMA forecast. The appropriateness of the ARIMA models was determined with the aid of the AIC criterion. The ARIMA model for the 3-month Euro (DEM) interest rate contains three autoregressive terms, the consideration of the first differences and three moving average terms. The ARIMA model for the 10-year German Government bond yield contains no autoregressive term, the consideration of the first differences and one moving average term.

The modified Diebold-Mariano test for forecast encompassing is applied here to examine whether the analysed forecast time series have a level of information content which goes significantly beyond a simple ARIMA forecast. The initial premise here is that a forecast situation y_k is described by two competing forecast models *i* and *j*:

$$\hat{y}_k = (1-\lambda)\,\hat{y}_{i,k} + \lambda\,\hat{y}_{j,k} \tag{8}$$

where $0 \leq \lambda \leq 1$. If $\lambda = 0$, then the forecasts generated by model *i* are said to encompass the forecasts generated by model *j*, as model *j* does not contribute any useful information – apart from that already contained in model *i* – to the formation of an optimal composite forecast. Harvey, Leybourne and Newbold (1998) develop a statistic to test the null hypothesis that $H_0 : \lambda = 0$ against the alternative that $H_1 : \lambda > 0$. If the null hypothesis is rejected, then the forecasts contain distinct predictive information which is useful in forming the optimal forecast $\hat{y}_k$.

INSERT TABLES 7-10

The results of the efficiency test are highly varied (Tables 7-10). In 47 out of 116 cases (40.5%), the interest rate data which was observed before the forecast was made is efficiently used in the forecasts.

The other investigation procedures provide a very divided picture. Both with regard to the sign accuracy tests as well as in comparison to naïve forecasts or ARIMA models, it is shown that the 3-month Euro (DEM) interest rate forecasts were significantly more successful than the 10-year German Government bond yield forecasts.

The sign accuracy test revealed that only four out of 58 time series (6.9%) of the 10-year German Government bond yield forecasts predicted the trend (rising or falling interest

rates) significantly better than a random process (Tables 7-8). In the case of the 3-month Euro (DEM) interest rate forecasts, however, 52 out of 58 time series (89.7%) are superior in comparison with a random process (Tables 9-10).

The situation is similar when the forecasts are compared with naïve forecasts or the ARIMA models. The quality of all 58 time series of the 10-year German Government bond yield forecasts are clearly poorer than that of the naïve forecasts and contain no significant additional information compared to the adjusted ARIMA model (Tables 7-8). The performance of the time series of the 3-month Euro (DEM) interest rate forecasts with a forecast horizon of 13 months (Table 9) is at least superior to the corresponding ARIMA model in 2 out of 29 cases, and are also better than naïve forecasts in nine out of 29 cases (31.0%). If the forecast horizon is four months, the number of forecast time series containing additional information to the adjusted ARIMA model even reaches 27 out of 29 (93.1%), and 28 out of 29 (96.6%) forecast time series are better than the corresponding time series of naïve forecasts (Table 10).

In summary, it can be stated that the time series of the 3-month Euro (DEM) interest rate forecasts are considerably more successful than the time series of the 10-year German Government bond yield forecasts. This is particularly true for the forecasts with a forecast horizon of four months.

6. STUDY RESULTS AND CONCLUSION

The study is concerned with the analysis of 116 interest rate forecast time series with 17,880 individual forecasts. The appropriate procedures are applied in order to evaluate the forecasts.

The efficiency test, the sign accuracy test, comparisons with naïve forecasts and ARIMA models lead to mixed results. The study reveals that the short-term forecast of the 3-month Euro (DEM) interest rate is most successful. It can be assumed that this is due to the considerable influence of the central bank on the short maturities sector of the money market and to the high transparency of the short and medium term financial policy of the European Central Bank (or the German Bundesbank).

A uniform picture only appears in the unbiasedness test and with the TOTA coefficients. All 116 forecast time series are characterised by a topically orientated trend adjustment. This results in the residuals exhibiting a certain pattern. During phases of falling (rising) interest rates, there are long periods of overestimation (underestimation) of the interest rate trend. The residuals are thus not independently distributed. Instead there are frequently 20, 30 or 40 overestimations in sequence before they are followed by a series of 20, 30 or 40 underestimations. This situation leads to the Durbin-Watson test identifying all 116 forecast time series as biased.

This link between topically orientated trend adjustment and autocorrelation of the residuals is very robust. It remains unchanged regardless of how the residuals are specifically defined: (a) The deviations between actual and forecast interest rates (b) The deviations between actual and forecast changes of the interest rates (c) The deviations from the regression line estimated in the forecast-realisation diagram (on the basis of actual and fore-

cast interest rates) or (d) The deviations from the regression line estimated in the forecast-realisation diagram (on the basis of actual and forecast changes in the interest rates).

In summary, it can be stated that in spite of some successes – particularly in the 3-month Euro (DEM) interest rate forecasts with a forecast horizon of four months – there is a considerable need for improvement in the work of interest rate forecasters in Germany which we analysed. It would be especially important to work towards avoiding topically orientated trend adjustments when making forecasts. The forecasters should therefore try to not let themselves be influenced as much by the current interest rate situation. Without this step, a general autocorrelation of the residuals and thus a general bias of the forecasts will remain inevitable in the future. The avoidance of topically orientated trend adjustments is, however, only a necessary precondition for the avoidance of autocorrelated residuals, but certainly not a sufficient precondition.

REFERENCES

Andres, P., Spiwoks, M. (1999), 'Forecast Quality Matrix: A Methodological Survey of Judging Forecast Quality of Capital Market Forecasts', *Journal of Economics and Statistics* 219, 513-542.

Bofinger, P., Schmidt, R. (2003), 'On the Reliability of Professional Exchange Rate Forecasts: An Empirical Analysis for the €/US-$ Rate', *Financial Markets and Portfolio Management* 17, 437-449.

Bofinger, P., Schmidt, R. (2004), *Should one rely on professional exchange rate forecasts? An empirical analysis of professional forecasts for the euro/US-Dollar-Rate*, Centre for Economic Policy Research London, Discussion Paper, No. 4235.

Diebold, F. X., Lopez, J. A. (1996), *Forecast Evaluation and Combination*, in: Maddala, G. S. and Rao, C. R. (eds.), Handbook of Statistics. 14, 241-268, Amsterdam.

Hanson, L. P., Hodrick, R. J. (1980), 'Forward Exchange Rates as Optimal Predictors of Future Spot Exchange Rates: An Econometric Analysis', *Journal of Political Economy* 88, 829-853.

Harvey, D. I., Leybourne, S. J., Newbold, P. (1998), 'Tests for Forecast Encompassing', *Journal of Business & Economic Statistics* 16, 254-259.

Joutz, F., Stekler, H. O. (2000), 'An evaluation of the predictions of the Federal Reserve', *International Journal of Forecasting* 16, 17-38.

Laplace, P. S. (1814), *Essai philosophique sur les probabilites*, Paris.

Newey, W. K., West, K. D. (1987), 'A Simple Positive Semi-Definite Heteroskedasticity and Autocorrelation Consistent Covariance Matrix', *Econometrica* 55, 703-708.

Simon, D. P. (1989), 'The Rationality of Federal Funds Rate Expectations: Evidence from a Survey', *Journal of Money, Credit, and Banking* 21, 388-393.

Spiwoks, M. (2003), 'Qualität der Zinsprognosen deutscher Banken: Eine empirische Analyse', *Kredit und Kapital* 36, 289-308.

Spiwoks, M. (2004), 'The Usefulness of ZEW Stock Market Forecasts for Active Portfolio Management Strategies', *Journal of Economics and Statistics* 224, 557-578.

Theil, H. (1955), *Who forecasts best?*, International Economic Papers, No. 5.

Theil, H. (1966), *Applied Economic Forecasting*, Amsterdam.

Theil, H. (1971), *Principles of Econometrics*, New York.

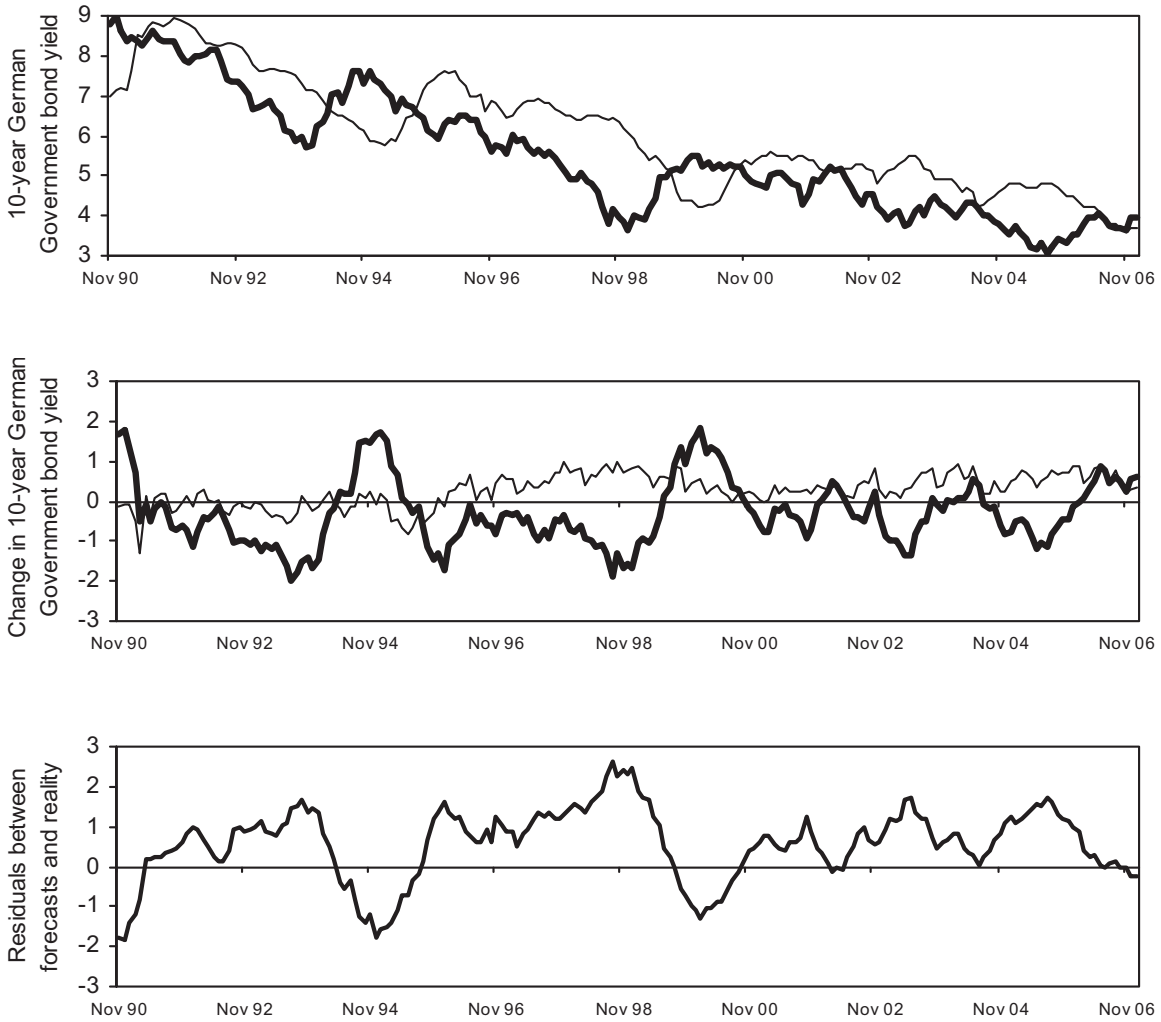

Diagram 1 Ten-year German Government bond yield in percent (top, bold line) and the corresponding forecast time series by Consensus Economics with a 13 month forecast horizon (top, thin line); actual (middle, bold line) and forecast (middle, thin line) change in the 10-year German Government bond yield in percentage points; deviation between forecast and reality in percentage points (bottom).

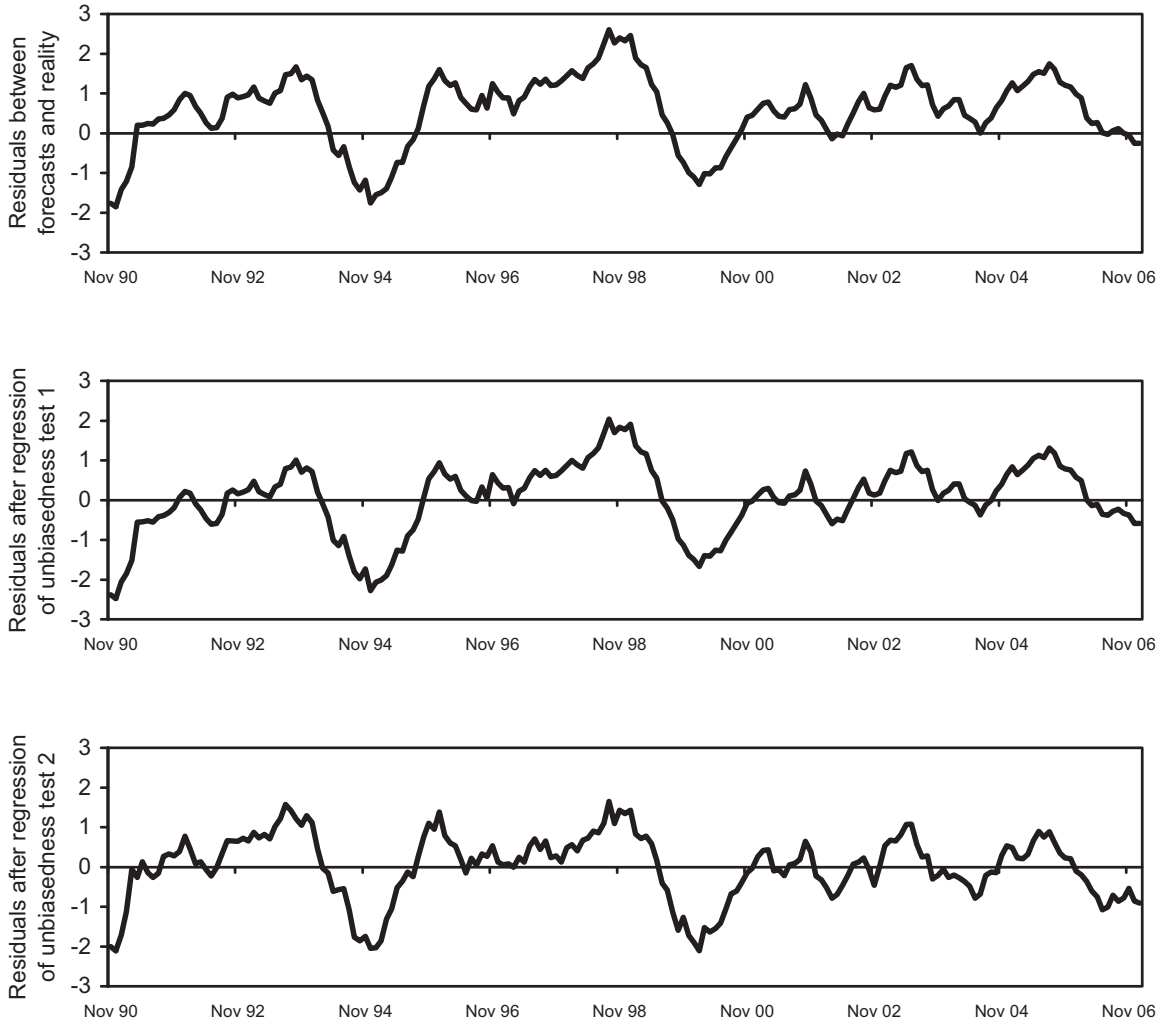

Diagram 2 Deviation between the 10-year German Government bond yield and the corresponding forecast time series from Consensus Economics in percentage points (top); deviation from the regression line estimated in the forecast-realisation diagram on the basis of the actual and forecast interest rates (middle); deviation from the regression line estimated in the forecast-realisation diagram on the basis of actual and forecast changes in interest rates (bottom).

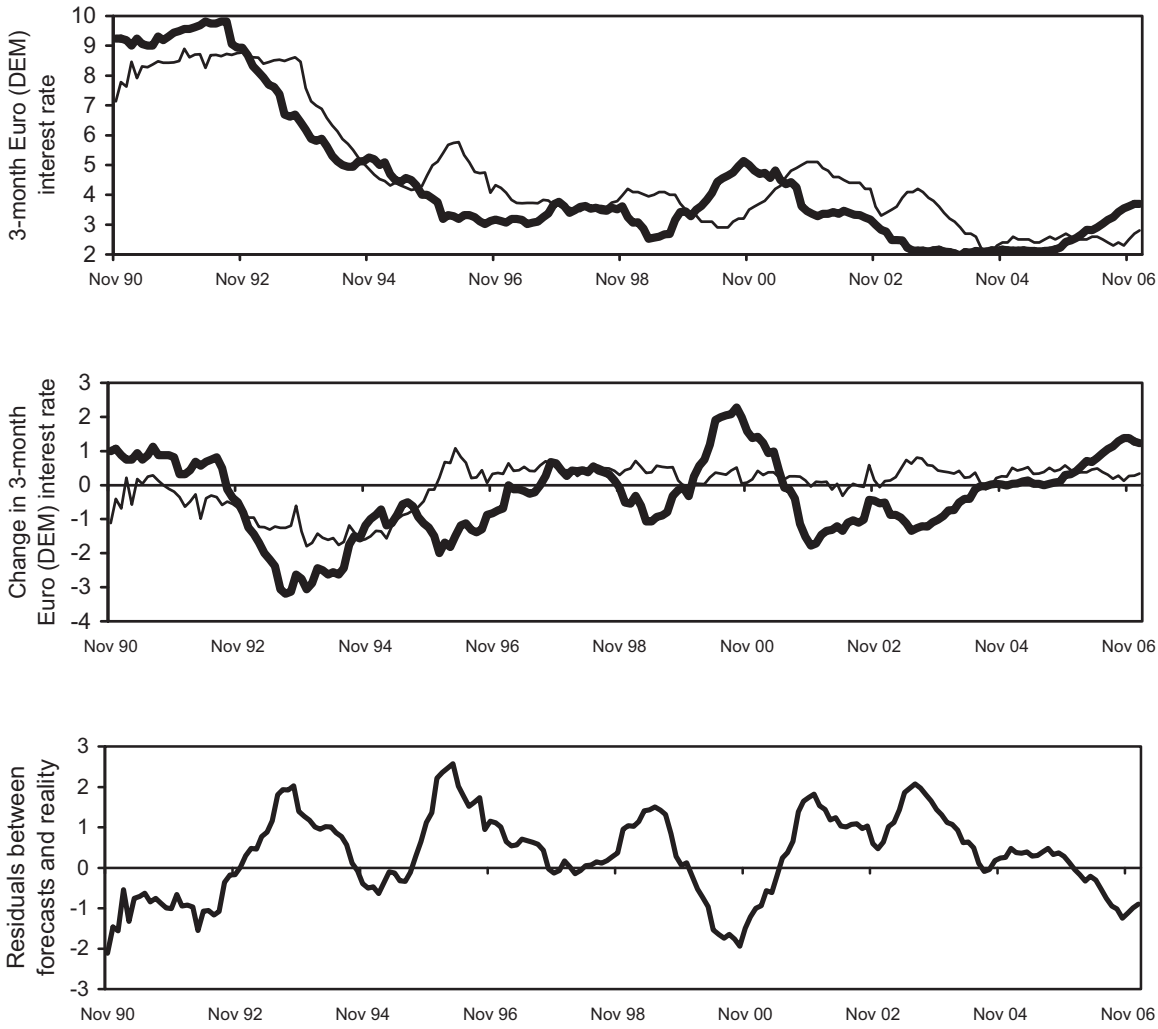

Diagram 3 Three-month Euro (DEM) interest rate in percent (top, bold line) and the corresponding forecast time series by Consensus Economics with a 13 month forecast horizon (top, thin line); actual (middle, bold line) and forecast (middle, thin line) change in the 3-month Euro (DEM) interest rate in percentage points; deviation between forecast and reality in percentage points (bottom).

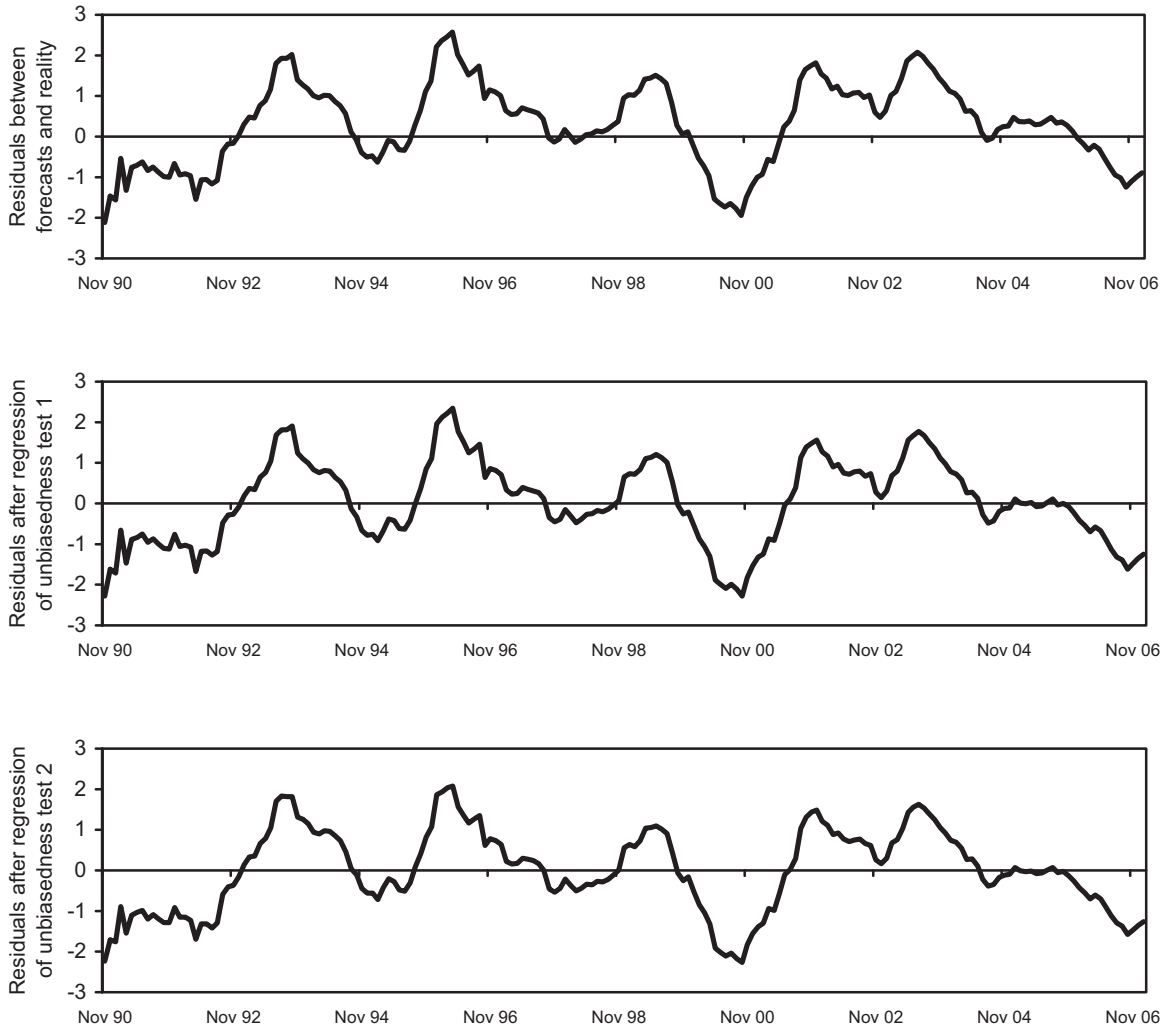

Diagram 4 Deviation between the 3-month Euro (DEM) interest rates and the corresponding forecast time series of Consensus Economics with a forecast horizon of 13 months in percentage points (top); deviation from the regression line estimated in the forecast-realisation diagram on the basis of the actual and forecast interest rates (middle); deviation from the regression line estimated in the forecast-realisation diagram on the basis of actual and forecast changes in interest rates (bottom).

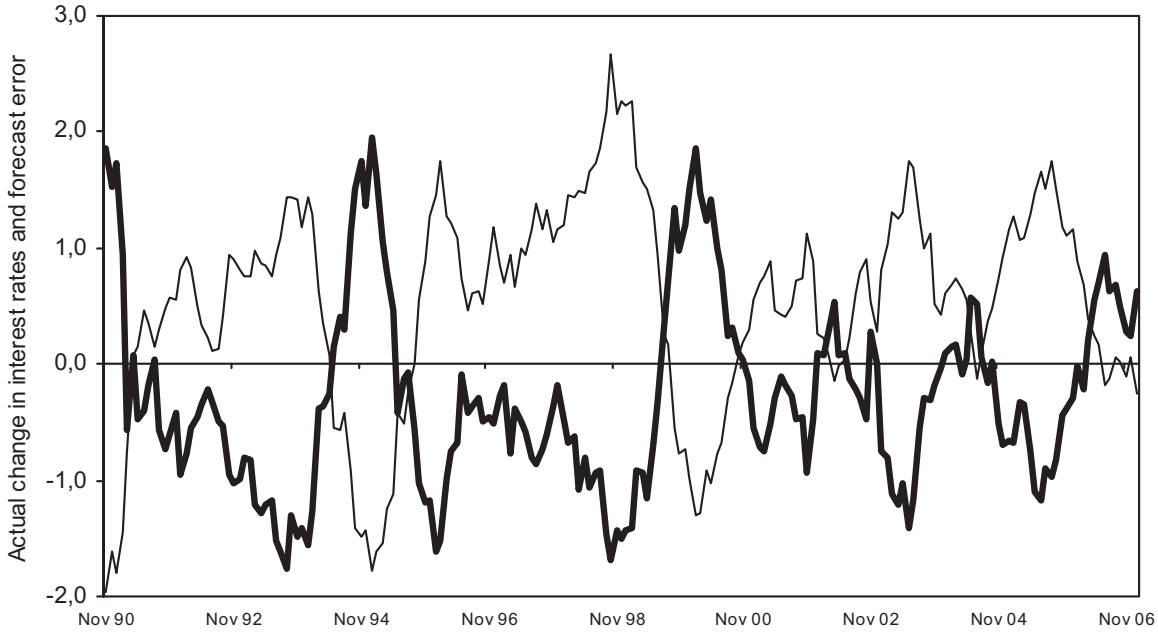

Diagram 5 Actual change in the 10-year German Government bond yield during the forecast horizon of 13 months in percentage points (bold line) and deviation between consensus forecasts and reality in percentage points (thin line).

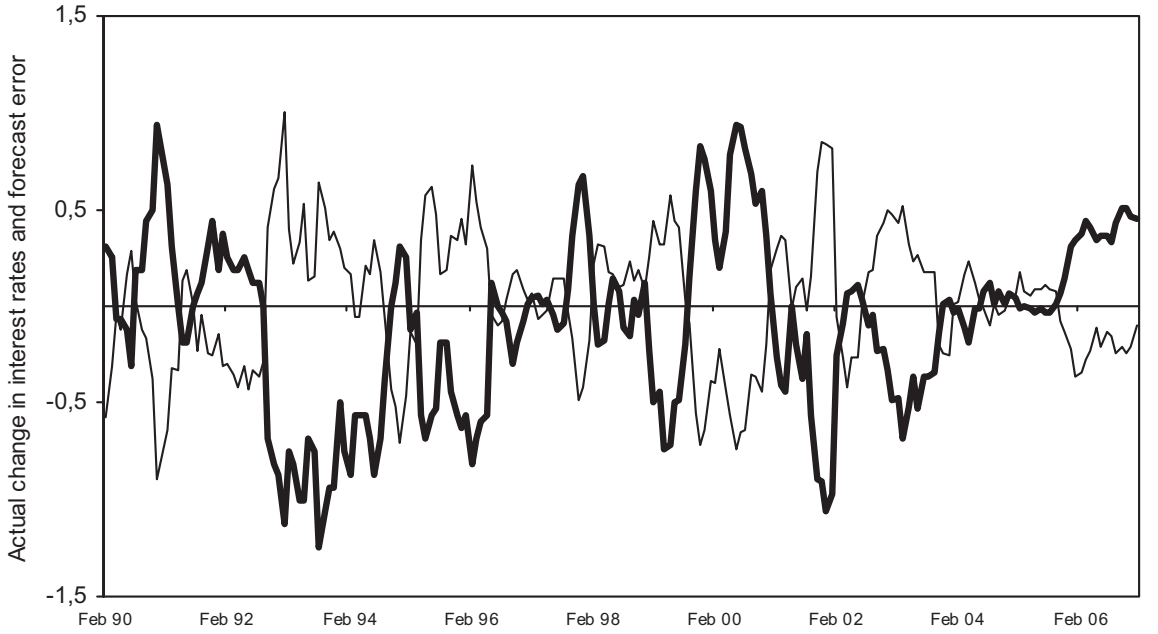

Diagram 6 Actual change in the 3-month Euro (DEM) interest rates during the forecast horizon of 4 months in percentage points (bold line) and deviation between consensus forecasts and reality in percentage points (thin line).

Table 1 Results of unbiasedness test of 10-year German Government bond yield forecasts with 13 months forecast horizon

Institution	*a*	st. dev.	*b*	st. dev.	F-dist.	crit. v.	DW	crit. v.
Consensus Econ.	-0.012	0.594	0.913	0.092	38.500	3.043	0.088	1.65
Bankges. Berlin	0.468	0.566	0.838	0.084	38.910	3.044	0.144	1.65
Bank Julius Bär	1.217	0.614	0.652	0.106	95.210	3.068	0.171	1.65
Bay. Landesbank	-0.487	0.665	0.982	0.097	45.018	3.044	0.188	1.65
Bay. Vereinsbank	0.856	1.373	0.809	0.175	16.994	3.089	0.186	1.65
BfG/SEB	0.000	0.577	0.894	0.090	54.897	3.043	0.111	1.65
Commerzbank	0.076	0.626	0.908	0.101	27.805	3.043	0.091	1.65
Delbrück	0.899	1.087	0.772	0.161	29.072	3.057	0.087	1.65
Deutsche Bank	-0.232	0.547	0.943	0.087	40.924	3.045	0.199	1.65
DG/DZ Bank	0.112	0.709	0.887	0.108	35.675	3.043	0.109	1.65
DGZ/Deka Bank	0.518	0.826	0.835	0.135	26.186	3.045	0.116	1.65
Dresdner Bank	-0.519	0.699	0.996	0.114	34.551	3.044	0.098	1.65
FAZ Info Dienste	0.370	0.727	0.817	0.118	58.227	3.053	0.121	1.65
Helaba	-0.001	0.529	0.876	0.078	88.674	3.044	0.147	1.65
HVB/Hypo-Bank	0.740	0.502	0.793	0.072	42.809	3.048	0.144	1.65
IfW Kiel	0.334	0.525	0.857	0.077	41.118	3.049	0.150	1.65
Invesco/BiL	3.243	1.191	0.257	0.215	115.834	3.090	0.115	1.64
IW Köln	1.466	0.803	0.550	0.152	75.630	3.175	0.329	1.53
JP Morgan	1.106	0.780	0.674	0.122	54.340	3.100	0.258	1.63
Lehmann Brothers	3.413	0.269	0.086	0.066	149.727	3.245	0.351	1.44
M.M. Warburg	1.833	0.628	0.573	0.115	43.820	3.061	0.092	1.65
Morgan Stanley	3.463	1.174	0.185	0.202	109.755	3.109	0.169	1.62
RWI Essen	1.305	0.962	0.620	0.178	87.384	3.082	0.162	1.65
Sal. Oppenheim	-0.044	0.719	0.926	0.113	23.421	3.048	0.106	1.65
SMH	1.387	2.123	0.719	0.265	23.757	3.087	0.101	1.65
Trinkaus & Burkh.	0.710	0.436	0.817	0.076	26.325	3.045	0.107	1.65
UBS	1.158	0.660	0.647	0.138	76.549	3.085	0.226	1.65
West LB	0.209	0.559	0.869	0.084	44.709	3.043	0.098	1.65
WGZ Bank	-0.117	0.619	0.942	0.103	22.613	3.047	0.122	1.65

F-test and Durbin-Watson test critical value on 0.05 significance level.

Table 2 Results of unbiasedness test of 10-year German Government bond yield forecasts with 4 months forecast horizon

Institution	*a*	st. dev.	*b*	st. dev.	F-dist.	crit. v.	DW	crit. v.
Consensus Econ.	-0.029	0.210	0.980	0.036	8.144	3.041	0.273	1.65
Bankges. Berlin	0.212	0.203	0.929	0.032	19.491	3.042	0.340	1.65
Bank Julius Bär	0.415	0.295	0.887	0.059	11.236	3.063	0.473	1.65
Bay. Landesbank	-0.295	0.185	1.025	0.031	11.534	3.042	0.519	1.65
Bay. Vereinsbank	0.606	0.502	0.895	0.065	4.699	3.088	0.317	1.65
BfG/SEB	-0.084	0.194	0.974	0.031	24.263	3.042	0.411	1.65
Commerzbank	-0.020	0.203	0.977	0.035	8.725	3.041	0.298	1.65
Delbrück	0.291	0.372	0.923	0.052	11.699	3.057	0.279	1.65
Deutsche Bank	-0.086	0.215	0.996	0.035	4.185	3.042	0.389	1.65
DG/DZ Bank	0.054	0.210	0.956	0.032	14.613	3.041	0.371	1.65
DGZ/Deka Bank	0.100	0.204	0.954	0.033	11.661	3.042	0.385	1.65
Dresdner Bank	-0.157	0.216	1.003	0.037	6.807	3.042	0.355	1.65
FAZ Info Dienste	-0.296	0.283	1.015	0.050	14.917	3.053	0.346	1.65
Helaba	0.006	0.188	0.960	0.031	22.662	3.042	0.457	1.65
HVB/Hypo-Bank	0.257	0.207	0.925	0.032	16.861	3.045	0.452	1.65
IfW Kiel	0.055	0.197	0.960	0.031	15.161	3.044	0.470	1.65
Invesco/BiL	1.300	0.388	0.694	0.073	37.287	3.090	0.471	1.65
IW Köln	0.282	0.356	0.877	0.074	29.584	3.138	0.692	1.57
JP Morgan	0.159	0.402	0.940	0.076	4.948	3.089	0.543	1.65
Lehmann Brothers	1.689	0.509	0.531	0.110	36.323	3.191	0.478	1.50
M.M. Warburg	0.522	0.324	0.875	0.066	7.884	3.057	0.298	1.65
Morgan Stanley	1.301	0.454	0.684	0.085	19.895	3.097	0.424	1.63
RWI Essen	0.206	0.380	0.921	0.074	10.018	3.075	0.400	1.65
Sal. Oppenheim	0.180	0.193	0.950	0.031	6.741	3.045	0.511	1.65
SMH	0.745	0.604	0.872	0.078	7.211	3.087	0.313	1.65
Trinkaus & Burkh.	0.337	0.192	0.930	0.030	6.149	3.043	0.298	1.65
UBS	-0.163	0.401	1.000	0.084	5.009	3.077	0.360	1.65
West LB	0.129	0.206	0.948	0.032	13.431	3.041	0.317	1.65
WGZ Bank	-0.044	0.161	0.988	0.027	5.056	3.044	0.414	1.65

F-test and Durbin-Watson test critical value on 0.05 significance level.

Table 3 Results of unbiasedness test of 3-month Euro (DEM) interest rate forecasts with 13 months forecast horizon

Institution	*a*	st. dev.	*b*	st. dev.	F-dist.	crit. v.	DW	crit. v.
Consensus Econ.	-0.467	0.481	1.039	0.102	8.904	3.000	0.079	1.65
Bankges. Berlin	-0.647	0.570	1.050	0.115	16.260	3.044	0.094	1.65
Bank Julius Bär	2.005	0.494	0.333	0.118	81.007	3.068	0.078	1.65
Bay. Landesbank	-0.644	0.421	1.080	0.081	11.232	3.044	0.191	1.65
Bay. Vereinsbank	-0.194	0.532	0.976	0.102	5.347	3.089	0.173	1.65
BfG/SEB	-0.433	0.470	1.012	0.099	15.144	3.043	0.097	1.65
Commerzbank	-0.351	0.566	1.007	0.128	10.354	3.043	0.119	1.65
Delbrück	-1.108	0.876	1.144	0.157	10.970	3.058	0.141	1.65
Deutsche Bank	-0.122	0.436	0.970	0.104	6.831	3.044	0.124	1.65
DG/DZ Bank	-0.544	0.529	1.029	0.114	15.172	3.043	0.146	1.65
DGZ/Deka Bank	-0.320	0.576	1.006	0.144	6.437	3.045	0.091	1.65
Dresdner Bank	-0.524	0.498	1.045	0.111	10.771	3.044	0.095	1.65
FAZ Info Dienste	0.291	0.483	0.809	0.103	39.551	3.053	0.093	1.65
Helaba	-0.320	0.457	0.984	0.093	15.002	3.044	0.131	1.65
HVB/Hypo-Bank	0.107	0.383	0.931	0.079	8.001	3.048	0.147	1.65
IfW Kiel	-0.296	0.562	1.006	0.112	5.098	3.049	0.102	1.65
Invesco/BiL	1.602	0.915	0.446	0.216	26.386	3.090	0.068	1.65
IW Köln	0.927	0.507	0.556	0.141	32.364	3.172	0.085	1.53
JP Morgan	1.793	0.514	0.358	0.125	96.219	3.100	0.203	1.63
Lehmann Brothers	2.677	0.535	-0.095	0.129	6.450	3.252	0.046	1.43
M.M. Warburg	1.826	0.695	0.409	0.169	45.396	3.061	0.063	1.65
Morgan Stanley	1.877	0.803	0.341	0.193	29.722	3.111	0.091	1.61
RWI Essen	1.743	0.562	0.400	0.131	50.066	3.082	0.099	1.65
Sal. Oppenheim	-0.349	0.547	1.046	0.130	*1.957*	3.048	0.146	1.65
SMH	-0.689	0.468	1.058	0.088	8.445	3.087	0.300	1.65
Trinkaus & Burkh.	0.027	0.464	0.977	0.107	*0.734*	3.045	0.092	1.65
UBS	1.545	0.309	0.416	0.079	166.58	3.084	0.236	1.65
West LB	-0.698	0.477	1.076	0.087	13.171	3.043	0.114	1.65
WGZ Bank	-0.787	0.539	1.105	0.114	9.240	3.047	0.128	1.65

F-test and Durbin-Watson test critical value on 0.05 significance level.

Table 4 Results of unbiasedness test of 3-month Euro (DEM) interest rate forecasts with 4 months forecast horizon

Institution	*a*	st. dev.	*b*	st. dev.	F-dist.	crit. v.	DW	crit. v.
Consensus Econ.	-0.045	0.086	1.004	0.018	*0.629*	3.041	0.333	1.65
Bankges. Berlin	-0.080	0.098	0.992	0.018	*1.054*	3.042	0.545	1.65
Bank Julius Bär	0.447	0.131	0.862	0.043	*1.116*	3.062	0.619	1.65
Bay. Landesbank	-0.159	0.093	1.043	0.022	8.208	3.042	0.453	1.65
Bay. Vereinsbank	0.015	0.135	0.988	0.233	*1.341*	3.088	0.548	1.65
BfG/SEB	-0.091	0.089	1.005	0.020	3.555	3.042	0.396	1.65
Commerzbank	-0.022	0.098	0.991	0.022	*2.860*	3.041	0.413	1.65
Delbrück	-0.189	0.149	1.019	0.026	4.055	3.057	0.450	1.65
Deutsche Bank	0.021	0.082	0.993	0.018	*0.307*	3.042	0.513	1.65
DG/DZ Bank	-0.079	0.094	1.001	0.020	4.021	3.041	0.425	1.65
DGZ/Deka Bank	0.053	0.095	0.979	0.023	*2.954*	3.042	0.450	1.65
Dresdner Bank	-0.062	0.104	1.008	0.024	*0.554*	3.042	0.364	1.65
FAZ Info Dienste	-0.025	0.125	0.977	0.029	8.373	3.053	0.354	1.65
Helaba	-0.057	0.080	1.007	0.016	*0.673*	3.042	0.559	1.65
HVB/Hypo-Bank	0.061	0.078	0.987	0.016	*0.888*	3.045	0.621	1.65
IfW Kiel	0.043	0.093	0.986	0.017	*1.232*	3.044	0.502	1.65
Invesco/BiL	0.196	0.236	0.936	0.072	*0.925*	3.090	0.398	1.65
IW Köln	0.158	0.276	0.940	0.107	*0.763*	3.137	0.197	1.58
JP Morgan	0.244	0.158	0.898	0.052	9.751	3.087	0.650	1.65
Lehmann Brothers	0.647	0.229	0.735	0.101	9.460	3.195	0.294	1.50
M.M. Warburg	0.135	0.123	0.954	0.037	*1.931*	3.057	0.440	1.65
Morgan Stanley	0.364	0.217	0.886	0.070	*2.844*	3.097	0.597	1.64
RWI Essen	0.173	0.181	0.956	0.058	*0.958*	3.074	0.488	1.65
Sal. Oppenheim	-0.046	0.102	1.018	0.025	*1.870*	3.045	0.483	1.65
SMH	0.023	0.125	0.995	0.023	*1.055*	3.087	0.571	1.65
Trinkaus & Burkh.	0.002	0.096	1.004	0.022	*0.263*	3.043	0.373	1.65
UBS	0.237	0.143	0.919	0.046	4.366	3.076	0.626	1.65
West LB	-0.025	0.085	1.000	0.017	*0.625*	3.041	0.474	1.65
WGZ Bank	-0.140	0.104	1.024	0.022	*2.102*	3.044	0.400	1.65

F-test and Durbin-Watson test critical value on 0.05 significance level.

Table 5 Results of TOTA coefficient

	10-year German Government bond yield		3-month Euro (DEM) interest rate	
Institution	13 months forecast hor.	4 months forecast hor.	13 months forecast hor.	4 months forecast hor.
Consensus Economics	0.691	0.910	0.882	0.987
Bankgesellsch. Berlin	0.731	0.922	0.859	0.988
Bank Julius Bär	0.617	0.840	0.243	0.909
Bayer. Landesbank	0.720	0.941	0.928	0.990
Bayer. Vereinsbank	0.604	0.875	0.990	0.989
BfG/SEB	0.695	0.928	0.880	0.987
Commerzbank	0.688	0.917	0.860	0.988
Delbrück	0.512	0.885	0.852	0.983
Deutsche Bank	0.704	0.926	0.889	0.992
DG Bank/DZ Bank	0.641	0.918	0.867	0.988
DGZ/Deka Bank	0.636	0.921	0.792	0.980
Dresdner Bank	0.693	0.912	0.882	0.981
FAZ Info Dienste	0.533	0.872	0.709	0.964
Helaba	0.744	0.928	0.876	0.993
HVB/Hypo-Bank	0.715	0.926	0.953	0.991
IfW Kiel	0.719	0.937	0.865	0.985
Invesco/BiL	0.133	0.704	0.238	0.879
IW Köln	0.406	0.857	0.345	0.843
JP Morgan	0.619	0.846	0.423	0.952
Lehmann Brothers	0.030	0.517	0.031	0.819
M.M. Warburg	0.417	0.796	0.271	0.948
Morgan Stanley	0.077	0.688	0.125	0.979
RWI Essen	0.520	0.838	0.257	0.910
Sal. Oppenheim	0.652	0.928	0.858	0.985
SMH	0.481	0.830	0.988	0.991
Trinkaus & Burkhardt	0.740	0.929	0.875	0.998
UBS	0.615	0.862	0.656	0.956
West LB	0.707	0.920	0.944	0.996
WGZ Bank	0.678	0.933	0.881	0.820

Table 6 coefficients of correlation (*corr*) and coefficients of determination (R^2) of the correlation between actual changes in interest rates and forecasts errors (consensus forecasts)

	10-year German Governm. bond yield		3-month Euro (DEM) interest rate	
	13 months forecast horizon	4 months forecast horizon	13 months forecast horizon	4 months forecast horizon
corr	-0.89	-0.85	-0.79	-0.88
R^2	0.79	0.73	0.62	0.77

Table 7 Results of efficiency test, sign accuracy test, modified Diebold-Mariano test for forecast encompassing and Theil's U_2 of 10-year German Government bond yield forecasts with 13 months forecast horizon

Institution	Effic. F-dist.	Effic. crit. v.	Sign ac. χ^2 -dist.	Sign ac. result	MDM t-dist.	MDM crit. v.	Theil's U_2
Consensus Econ.	*0.975*	2.420	0.889	o	-0.608	1.653	1.189
Bankges. Berlin	2.830	2.421	1.000	o	-0.063	1.653	1.173
Bank Julius Bär	8.249	2.444	1.159	o	-1.037	1.657	1.190
Bay. Landesbank	*0.452*	2.421	5.832	+	-0.177	1.653	1.287
Bay. Vereinsbank	*1.033*	2.469	1.248	o	0.454	1.660	1.045
BfG/SEB	*1.193*	2.420	0.278	o	-1.012	1.653	1.245
Commerzbank	*1.830*	2.420	1.741	o	-0.322	1.653	1.192
Delbrück	*0.373*	2.434	0.379	o	-0.868	1.655	1.309
Deutsche Bank	*0.665*	2.421	3.468	+	0.016	1.653	1.229
DG/DZ Bank	*0.792*	2.420	0.091	o	-0.974	1.653	1.348
DGZ/Deka Bank	*1.285*	2.422	0.126	o	-1.512	1.653	1.274
Dresdner Bank	*1.295*	2.421	0.459	o	0.011	1.653	1.205
FAZ Info Dienste	*0.646*	2.429	1.071	o	-0.409	1.654	1.285
Helaba	2.905	2.421	0.879	o	-1.327	1.653	1.332
HVB/Hypo-Bank	4.912	2.426	0.065	o	-1.003	1.654	1.237
IfW Kiel	*1.704*	2.426	0.755	o	-0.016	1.664	1.130
Invesco/BiL	6.867	2.469	4.370	+	-0.862	1.661	1.365
IW Köln	*0.981*	2.561	0.021	o	-2.795	1.674	1.664
JP Morgan	*1.816*	2.479	1.336	o	-1.884	1.662	1.507
Lehmann Brothers	*0.662*	2.642	1.905	o	-1.017	1.685	1.452
M.M. Warburg	*1.999*	2.438	2.922	o	-1.611	1.656	1.319
Morgan Stanley	8.877	2.489	0.035	o	-1.168	1.664	1.398
RWI Essen	2.964	2.460	4.496	o	-1.177	1.659	1.436
Sal. Oppenheim	*0.781*	2.424	0.011	o	-0.688	1.654	1.276
SMH	*0.148*	2.468	8.423	-	-0.845	1.660	1.300
Trinkaus & Burkh.	5.141	2.423	0.000	o	-0.229	1.653	1.340
UBS	*1.906*	2.463	1.112	o	-1.274	1.660	1.458
West LB	*0.869*	2.421	0.067	o	-0.600	1.653	1.256
WGZ Bank	*0.337*	2.424	2.345	o	-0.196	1.653	1.205

Efficiency F-test critical value on 0.05 significance level; sign accuracy χ^2 test critical value on 0.05 significance level = 3.8414; o = not significantly different from a random process; + = significantly better than a random process; - = significantly worse than a random process. Modified Diebold-Mariano test (MDM) critical value on 0.05 significance level.

Table 8 Results of efficiency test, sign accuracy test, modified Diebold-Mariano test for forecast encompassing and Theil's U_2 of 10-year German Government bond yield forecasts with 4 months forecast horizon

Institution	Effic. F-dist.	Effic. crit. v.	Sign ac. χ^2 -dist.	Sign ac. result	MDM t-dist.	MDM crit. v.	Theil's U_2
Consensus Econ.	5.672	2.418	1.252	o	-0.718	1.652	1.133
Bankges. Berlin	5.009	2.419	1.764	o	0.115	1.653	1.240
Bank Julius Bär	*2.397*	2.440	1.764	o	-2.644	1.656	1.268
Bay. Landesbank	2.478	2.419	2.558	o	1.536	1.653	1.057
Bay. Vereinsbank	2.590	2.469	0.002	o	0.937	1.660	1.044
BfG/SEB	3.209	2.419	0.324	o	0.470	1.653	1.136
Commerzbank	7.655	2.418	2.723	o	0.060	1.653	1.143
Delbrück	4.770	2.435	2.010	o	-0.207	1.655	1.262
Deutsche Bank	2.422	2.419	0.198	o	0.907	1.653	1.176
DG/DZ Bank	3.334	2.418	0.832	o	-0.094	1.652	1.288
DGZ/Deka Bank	2.946	2.420	0.469	o	0.182	1.653	1.154
Dresdner Bank	4.758	2.419	0.086	o	-0.176	1.653	1.143
FAZ Info Dienste	3.759	2.430	0.001	o	-0.699	1.654	1.265
Helaba	2.763	2.419	0.516	o	0.321	1.653	1.178
HVB/Hypo-Bank	4.914	2.423	5.006	-	0.099	1.653	1.252
IfW Kiel	3.400	2.421	0.079	o	0.989	1.653	1.100
Invesco/BiL	5.940	2.469	6.340	-	-1.242	1.661	1.252
IW Köln	*1.681*	2.520	8.346	+	0.786	1.668	1.215
JP Morgan	*1.036*	2.468	4.833	-	-1.441	1.660	1.346
Lehmann Brothers	5.700	2.579	1.579	o	-1.162	1.677	1.280
M.M. Warburg	2.661	2.434	5.502	-	-2.311	1.655	1.268
Morgan Stanley	2.600	2.475	0.298	o	-0.928	1.662	1.347
RWI Essen	4.011	2.453	7.140	-	-1.922	1.658	1.332
Sal. Oppenheim	2.468	2.422	0.074	o	0.691	1.653	1.109
SMH	2.634	2.468	0.240	o	0.273	1.660	1.170
Trinkaus & Burkh.	5.258	2.420	2.057	o	0.782	1.663	1.161
UBS	2.843	2.455	0.509	o	-0.524	1.658	1.427
West LB	3.815	2.418	0.306	o	-0.004	1.653	1.223
WGZ Bank	2.791	2.422	1.132	o	0.907	1.653	1.089

Efficiency F-test critical value on 0.05 significance level; sign accuracy χ^2 test critical value on 0.05 significance level = 3.8414; o = not significantly different from a random process; + = significantly better than a random process; - = significantly worse than a random process. Modified Diebold-Mariano test (MDM) critical value on 0.05 significance level.

Table 9 Results of efficiency test, sign accuracy test, modified Diebold-Mariano test for forecast encompassing and Theil's U_2 of 3-month Euro (DEM) interest rate forecasts with 13 months forecast horizon

Institution	Effic. F-dist.	Effic. crit. v.	Sign ac. χ^2 -dist.	Sign ac. result	MDM t-dist.	MDM crit. v.	Theil's U_2
Consensus Econ.	*1.310*	2.420	18.280	+	1.437	1.653	*0.952*
Bankges. Berlin	3.451	2.421	16.290	+	1.457	1.653	1.072
Bank Julius Bär	18.100	2.444	6.505	+	-0.248	1.657	1.082
Bay. Landesbank	2.612	2.421	16.918	+	1.573	1.653	*0.930*
Bay. Vereinsbank	*0.696*	2.469	30.377	+	1.358	1.660	1.000
BfG/SEB	*1.888*	2.421	10.451	+	1.473	1.653	*0.979*
Commerzbank	*0.888*	2.420	6.663	+	1.327	1.653	1.042
Delbrück	4.156	2.436	0.002	o	1.066	1.655	1.098
Deutsche Bank	*0.673*	2.421	14.072	+	1.466	1.653	*0.920*
DG/DZ Bank	*1.523*	2.420	8.024	+	1.368	1.653	1.029
DGZ/Deka Bank	3.091	2.422	2.301	o	1.094	1.653	1.006
Dresdner Bank	*2.136*	2.422	6.829	+	*1.666*	1.653	*0.932*
FAZ Info Dienste	*1.326*	2.430	24.323	+	1.445	1.654	*0.970*
Helaba	*0.878*	2.421	10.150	+	1.225	1.653	1.022
HVB/Hypo-Bank	*2.384*	2.426	35.460	+	*1.728*	1.654	*0.931*
IfW Kiel	*1.875*	2.426	6.179	+	1.208	1.654	1.035
Invesco/BiL	3.777	2.469	15.049	+	1.218	1.651	1.077
IW Köln	7.469	2.557	2.541	o	-0.343	1.674	1.212
JP Morgan	6.182	2.479	10.057	+	-0.071	1.662	1.292
Lehmann Brothers	19.530	2.650	1.117	o	-0.676	1.686	1.219
M.M. Warburg	*1.774*	2.438	17.506	+	1.175	1.656	1.030
Morgan Stanley	3.185	2.490	4.840	+	0.787	1.664	1.550
RWI Essen	9.723	2.460	16.175	+	0.807	1.659	*0.995*
Sal. Oppenheim	2.484	2.425	4.196	+	1.246	1.654	*0.987*
SMH	*1.255*	2.467	15.216	+	1.586	1.660	*0.866*
Trinkaus & Burkh.	*0.908*	2.423	1.659	+	1.266	1.653	1.038
UBS	20.870	2.462	7.208	+	0.499	1.659	1.037
West LB	3.122	2.420	16.203	+	1.439	1.653	1.064
WGZ Bank	4.086	2.424	4.900	+	1.190	1.653	1.056

Efficiency F-test critical value on 0.05 significance level; sign accuracy χ^2 test critical value on 0.05 significance level = 3.8414; o = not significantly different from a random process; + = significantly better than a random process; - = significantly worse than a random process. Modified Diebold-Mariano test (MDM) critical value on 0.05 significance level.

Table 10 Results of efficiency test, sign accuracy test, modified Diebold-Mariano test for forecast encompassing and Theil's U_2 of 3-month Euro (DEM) interest rate forecasts with 4 months forecast horizon

Institution	Effic. F-dist.	Effic. crit. v.	Sign ac. χ^2 -dist.	Sign ac. result	MDM t-dist.	MDM crit. v.	Theil's U_2
Consensus Econ.	5.632	2.417	28.342	+	*4.803*	1.652	*0.786*
Bankges. Berlin	4.273	2.419	29.674	+	*4.160*	1.653	*0.870*
Bank Julius Bär	7.767	2.439	17.179	+	*3.716*	1.656	*0.895*
Bay. Landesbank	7.008	2.419	21.997	+	*4.396*	1.653	*0.781*
Bay. Vereinsbank	*1.662*	2.469	10.750	+	*3.786*	1.660	*0.841*
BfG/SEB	5.661	2.419	20.107	+	*4.996*	1.653	*0.818*
Commerzbank	3.411	2.418	19.177	+	*4.175*	1.652	*0.978*
Delbrück	4.954	2.435	5.310	+	*4.209*	1.655	*0.933*
Deutsche Bank	3.097	2.419	22.051	+	*4.783*	1.653	*0.816*
DG/DZ Bank	3.876	2.418	23.664	+	*4.841*	1.652	*0.858*
DGZ/Deka Bank	10.610	2.420	19.904	+	*4.953*	1.653	*0.839*
Dresdner Bank	6.704	2.419	15.657	+	*4.670*	1.653	*0.856*
FAZ Info Dienste	3.269	2.430	3.201	o	*2.441*	1.654	*0.997*
Helaba	*1.695*	2.419	19.447	+	*3.975*	1.653	*0.829*
HVB/Hypo-Bank	3.786	2.422	35.188	+	*4.582*	1.653	*0.807*
IfW Kiel	7.202	2.421	11.983	+	*3.810*	1.653	*0.900*
Invesco/BiL	*1.138*	2.469	15.607	+	*3.580*	1.653	*0.935*
IW Köln	14.990	2.518	7.152	+	1.648	1.668	*0.933*
JP Morgan	2.847	2.465	6.189	+	*2.925*	1.660	*0.912*
Lehmann Brothers	8.749	2.584	0.060	o	0.964	1.677	1.028
M.M. Warburg	*0.533*	2.434	28.975	+	*3.689*	1.655	*0.807*
Morgan Stanley	*0.842*	2.475	19.488	+	*3.300*	1.662	*0.939*
RWI Essen	*1.350*	2.452	12.934	+	*2.654*	1.658	*0.979*
Sal. Oppenheim	6.771	2.422	18.621	+	*4.073*	1.653	*0.833*
SMH	*2.049*	2.467	24.727	+	*4.632*	1.660	*0.736*
Trinkaus & Burkh.	3.169	2.420	4.410	+	*4.462*	1.654	*0.848*
UBS	*2.203*	2.453	14.336	+	*2.923*	1.658	*0.894*
West LB	3.175	2.418	21.225	+	*4.787*	1.652	*0.836*
WGZ Bank	8.157	2.422	9.697	+	*3.746*	1.653	*0.905*

Efficiency F-test critical value on 0.05 significance level; sign accuracy χ^2 test critical value on 0.05 significance level = 3.8414; o = not significantly different from a random process; + = significantly better than a random process; - = significantly worse than a random process. Modified Diebold-Mariano test (MDM) critical value on 0.05 significance level.