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Forecasting inflation for transition countries: How accurate are the EBRD forecasts?

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Abstract

This paper analyses the statistical properties of annual inflation forecasts prepared by the EBRD for 25 transition countries between 1994 and 2005. The empirical results show that EBRD forecasts are mostly unbiased. Late within-year forecasts are also found to be efficient. Forecast accuracy is shown to be related to four main factors: timely availability of monthly data, decline in price volatility over time, general progress in transition reforms, and exchange rate developments. The late within-year forecasts of the EBRD were found to be on average better by 2.5 percentage points compared with other institutions but no better than forecasts based on a formal ARIMA inflation model.

Keywords: forecasting, inflation, bias, transition, EBRD

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INTRODUCTION AND LITERATURE REVIEW

This paper analyses the performance of inflation forecasts presented in the EBRD *Transition Report* over the past ten years. The literature on forecast accuracy suggests that assessments of forecast performance are a useful tool in preparing forecasts, as information on the properties of forecast errors may lead to substantial improvements in the accuracy of future forecasts.

The standard approach of forecast accuracy analyses (see for example, Holden and Peel 1990; Fildes and Stekler, 2002; and Timmermann, 2006) is to investigate the bias of forecasts, their efficiency in terms of incorporating all available information, and their relative performance compared with other forecasts of the same indicator, either prepared by other institutions or provided by formal models. Further, the forecasts are tested for potential improvements in accuracy over time. The assessments of forecast performance also sometimes compare different regions, for example, forecast performance for developed versus developing countries. The presence of outliers and their impact on forecast accuracy as well as weights given to past observations in preparing forecasts also need to be investigated.

Analysis of forecast performance is regularly undertaken by international financial institutions, such as the IMF (Kenen and Schwartz, 1986; Artis, 1988; Barrionuevo, 1992; Artis 1996; Pons, 2000; Loungani, 2001; Timmermann, 2006) and the OECD (Ash *et al*., 1990; Ash *et al*., 1998; Koutsogeorgopoulou, 2000). The papers listed above found that the forecasts prepared by the IMF and the OECD are generally unbiased and efficient. The evidence on comparative performance of forecasts by different institutions, including private forecasters, is mixed, depending on the selection of countries and time period covered (Batchelor, 2001). A similar analysis of forecast accuracy in the case of the EBRD has been done only for GDP growth forecasts so far (Krkoska and Teksoz, 2005).

Forecasting inflation in transition countries has been more challenging compared with mature market economies covered by most of the literature. In the last fifteen years transition countries[1] have moved from the centrally planned system where virtually all prices were fixed by the authorities towards the market system where most prices, except for utilities and housing, are determined by the balancing of supply and demand. This process initially led to high levels of consumer price inflation, reaching three, in some cases four-digit levels a year. In recent years consumer prices have stabilised in most countries and annual inflation in transition countries is now on average at single digit levels. Price liberalisation was accompanied by macroeconomic stabilisation efforts, including in some cases the use of a fixed exchange rate regime as a monetary anchor, and a wide range of structural reforms (such as the removal of exchange rate restrictions, liberalisation of internal and external trade, and removal of many market distorting subsidies).

1 The countries covered are: Central Europe and the Baltic states (CEB): Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovak Republic, and Slovenia,; south-eastern Europe (SEE): Albania, Bulgaria, Croatia, FYR Macedonia, and Romania; and the Commonwealth of Independent States (CIS): Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyz Republic, Moldova, Russia, Tajikistan, Turkmenistan, Ukraine and Uzbekistan. Data for Bosnia and Herzegovina, Montenegro, and Serbia are not available on a consistent basis for most of the analysed period and were thus excluded from the sample.

Tests of forecast efficiency, that is, whether forecasts utilise all the available information at any given point in time, are related to the question of the impact of potential determinants of inflation on the forecast performance. Determinants of inflation are the subject of a vast body of literature, traditionally based on the Phillips curve, the statistical relationship between inflation and aggregate indicators of economic activity. A good overview of issues related to forecasting inflation is provided by Stock and Watson (1999) while general principles of forecasting, applicable also for inflation forecasting, are provided by Armstrong (2001). Other relevant papers with the most up to date analyses of inflation forecasting include Brave and Fisher (2004) for the US and Clements (2004) for the UK. The IMF also publishes extensive assessments of inflation determinants for individual transition countries or groups of countries (see, for example, Aisen and Veiga, 2005, for a recent panel data analysis of specific determinants of inflation).

Among the many potential monetary and non-monetary determinants of inflation tested, the only factor robust to different specifications across all transition countries is the exchange rate. This explains more than 90 per cent of the variation in the annual average inflation rate and also has a strong impact on forecast accuracy. The choice of the exchange rate regime[2] is strongly related both with the level of inflation and with the forecast accuracy. The level of inflation is on average twice as high in countries with flexible exchange rates as in countries with fixed exchange rate regime. The forecast accuracy has a mean absolute forecast error twice as high in countries with flexible exchange rate regimes as in countries with fixed exchange rate regimes.

It should be noted that official estimates of economic data are usually subject to revisions either due to additional information available to statistical agencies or due to methodological changes, introducing further source of errors in forecasts, namely estimation errors. In the case of consumer inflation such changes are rare, although they do occur. Attention has therefore been paid to the timing of the official statistics used in evaluating forecast accuracy (see Fildes and Stekler, 2002, for a detailed discussion of the use of official estimates for forecast evaluation).

The rest of the paper is organised as follows: The next section provides the definitions and description of models used in the paper. The second section provides an overview of the data used in the paper, including a description of the EBRD's forecasting process. The third section presents the empirical results around three main topics: basic statistical properties of EBRD forecasts (bias, efficiency), forecast accuracy, and the comparison of EBRD forecasts with other forecasts. The fourth section concludes and suggests ways to improve forecasting of inflation for transition countries as well as potential extensions of the paper.

[2] See EBRD *Transition Report* 2005 for the most recent overview of the monetary and exchange rate regimes in all transition countries and past issues of annual EBRD *Transition Reports* for the historical developments in monetary and exchange rate policies.

1. ANALYTICAL FRAMEWORK

In this paper, the forecast time series of a macroeconomic indicator, in this case inflation, is denoted as $\{x_{i,t}\}$, where i is the country and t is the time period of non-negligible length. Furthermore, the true value of the macroeconomic indicator at time t is denoted as $x_{i,t}$, its forecast at time t-1 as $x_{i,t|t-1}$ (referred to as year-ahead forecast), its forecast at the beginning of time period t as $x_{i,t|t-}$ (referred to as early within-year forecast), and its forecast towards the end of time period t as $x_{i,t|t+}$ (referred to as late within-year forecast). Since the true value of many macroeconomic indicators cannot be observed directly and statistical offices provide only estimates for variables such as inflation (usually on the basis of surveys), the first estimates that are available are denoted $x_{i,t|t+1}$, and estimates published with a one-year time lag $x_{i,t|t+2}$.

The definition of forecast and estimation errors is based on the definitions of the forecast time series. The forecast error one time period ahead is defined as $\varepsilon_{i,t|t-1} = x_{i,t} - x_{i,t|t-1}$, the forecast error at the beginning of the time period t is $\varepsilon_{i,t|t-} = x_{i,t} - x_{i,t|t-}$, the forecast error at the end of the time period t is $\varepsilon_{i,t|t+} = x_{i,t} - x_{i,t|t+}$, the estimation error one period later is $\varepsilon_{i,t|t+1} = x_{i,t} - x_{i,t|t+1}$, and the estimation error two periods later is $\varepsilon_{i,t|t+2} = x_{i,t} - x_{i,t|t+2}$.

As noted earlier, the true value of a macroeconomic indicator is not always revealed, and therefore forecast errors cannot be directly observed either. Customarily, forecast accuracy assessments are based on the differences between the forecast and the estimate which are equivalent to the differences between unobserved forecast and estimation errors:

$$x_{i,t|s} - x_{i,t|r} = [x_{i,t} - x_{i,t|r}] - [x_{i,t} - x_{i,t|s}] = \varepsilon_{i,t|r} - \varepsilon_{i,t|s},$$

where $s, r = t-1, t-, t+, t+1, t+2$, and $r<s$.

In order to test the individual hypotheses, some relatively strong assumptions must be made to have reasonable sample characteristics, namely that forecast/estimation errors are independently and identically distributed across countries and time. This assumption can be relaxed to allow for variation by country, sub-region and time. Based on suggestions presented in Harvey and Newbold’s 2003 study of the properties of forecast errors, this paper uses robust testing methods on the basis of Student’s t-distribution with low degrees of freedom.

There is a wide range of potential formal models of inflation, which can be used to forecast inflation and consequently used to judge the forecast performance. One large group of models is based on the time series approach using lagged values of inflation as explanatory variables (ARIMA models). The simplest version of an ARIMA model is the so-called naïve forecast, where the last period outcome is used as the forecast for the next period. The naïve forecast is an important benchmark used in the literature on forecast evaluation as a minimum benchmark against which all forecasts should be measured (Fildes and Stekler, 2002).

More elaborate ARIMA models require a long time series. One such model has been built for this paper using an expanded dataset based on the available monthly time series. Since the basic forecasting period throughout the paper is one year and the EBRD forecasts average annual inflation, the ARIMA model based on monthly data to forecast annual inflation is used.

The general ARIMA inflation model is based on the following process:

$$\inf_{i,m} = \alpha + \beta(L) \cdot \inf_{i,m} + u_{i.m}, \qquad (1)$$

where $inf_{i,m}$ is customarily defined as a difference in logarithms of consumer price index in month m for country i, L is the lag operator, $\beta(L) = \sum_{n=1}^{N_i} \beta_i \cdot L^n$, N_i is the number of lagged values used for country i, and $u_{i.m}$ is an i.i.d. random term.

There are several issues to consider when selecting the specification of the ARIMA model to use for forecasting. The first issue is the stationarity of the analysed time series. In this paper the first difference in logarithms of monthly consumer price index is stationary (on the basis of Augmented Dickey-Fuller tests) for all countries, except Belarus, where the second difference achieves stationarity. The second issue is the selection of the number of lags, both how many lags to use and whether to use the same number of lags for all countries or have a different model for each country. On the basis of autocorrelation and partial autocorrelation analysis of the full set of the data for all individual countries, only the first and twelfth lags have been used, that is, $N_i = N = 12$ for all i and $\beta_j = 0$ for $j = 2,...,11$. One reason for such a selection is the clear economic explanation for the use of the first lag (price setting is influenced by inflation expectations which are in turn formed on the basis of inflation in the past) and the twelfth lag (seasonality effect). This selection also minimises the risks that the model would be too much data driven.

However, this selection comes at a cost, restricting the parameters of the model and limiting the goodness of fit. It might be possible to get a better fit for this particular dataset by relaxing the aforementioned restrictions on lags. All things considered, the restricted version of the model was preferred for the purposes of this paper in order to reach more general conclusions about forecast accuracy relative to a simple formal model, while acknowledging that better formal models may exist. Note that the ARIMA model is used to forecast monthly inflation which is consequently transformed into annual average inflation for the forecast accuracy assessment, given that all the other forecasts are prepared on an annual basis.

The second group of models used for forecast accuracy comparison is based on the statistical relationship between inflation and other economic and financial indicators. The most common indicators in these types of models are unemployment, real GDP growth, real GDP growth gap, interest rates, and monetary aggregates. However, for developed market economies, such as the US, a large number of disaggregated indicators on employment, output, and financial sector indicators are often used (Brave and Fisher, 2004). Given data availability concerns, the empirical analysis in this paper focuses only on a subset of main economic indicators readily available for all transition countries.[3] The second type of model can be written in the following general form:

$$\inf_{i,t} = \alpha + \beta(L) \cdot \inf_{i,t} + \gamma(L) \cdot Z_{i,t} + u_{i.t} \,, \qquad (2)$$

where Z is the vector of economic / financial indicators, L is the lag operator, $\beta(L) = \sum_{n=1}^{N_i} \beta_i \cdot L^n$, $\gamma(L) = \sum_{m=1}^{M_i} \gamma_i \cdot L^m$, and $u_{i.t}$ is an i.i.d. random term.

[3] The indicators of economic activity used in the paper are oil prices, interest rates, exchange rates, broad money growth, credit growth, current account balance, net current transfers, foreign direct investment inflows, non-FDI inflows, fiscal balance, GDP growth, and unemployment.

2. DATA DESCRIPTION AND BACKGROUND INFORMATION

The EBRD has been providing current year forecasts of inflation, as well as other macroeconomic indicators, since 1994, and year-ahead forecasts since 1996. In addition to inflation forecasts, the *Transition Report* contains current year and one-year-ahead forecasts of GDP growth and current year forecasts of general government balance, current account balance, trade balance, merchandise imports, merchandise exports, GDP in local currency and the current account to GDP ratio. Three forecasts with different lead times are available: one-year-ahead forecasts (forecasts for the following year published in the *Transition Report* in November); early within-year forecasts (forecasts for the current year published in the *Transition Report Update* in May); and late within-year forecasts (forecasts for the current year published in the *Transition Report* in November). The forecasts are usually finalised no later than one month before the publication release for technical reasons.

EBRD forecasts are based on a judgemental forecasting technique, using all available information on major economic and political developments. Information on progress in transition reforms [4] and the knowledge about forecast errors in the past is also used. Judgemental forecasting is used instead of a formal econometric model mainly due to the limited availability of the necessary times series for all transition countries. Simple modelling techniques are however applied by individual forecasters on a non-systemic basis during the preparation of forecasts, particularly for countries where the available information allows such an approach. The EBRD forecasts are complemented by forecasts from other institutions (both public and private) which allow the users to combine forecasts to reduce forecast errors (see Batchelor and Dua, 1995 and Fildes and Stekler, 2002 on the advantages of combining forecasts).

Only a small number of forecasters, mostly based in public or academic institutions, forecast inflation and other macroeconomic indicators for a wide range of transition countries. The EBRD *Transition Report* presents selected forecasts by the leading forecasters for transition countries, including both public and private institutions.[5] This paper provides a comparison of forecast accuracy for the forecasts prepared by the EBRD and other institutions. However, forecasts by different institutions presented in the *Transition Reports* are not prepared at the same time as EBRD forecasts. They are available to the EBRD before it finalises its forecasts, and thus are not independent and contemporaneous. Therefore, the data do not allow direct comparison of the performance of different forecasters. Nevertheless, interactions among forecasts prepared by different institutions within a relatively short time period from each other can be analysed.

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4 Progress in transition reform refers throughout the paper to nine main areas assessed in the annual EBRD *Transition Reports*: large-scale privatisation, small-scale privatisation, government and enterprise restructuring, price liberalisation, trade and foreign exchange system, competition policy, banking reform and interest rate liberalisation, securities markets and non-banking financial institutions, and infrastructure reform.

5 The other forecasters include international financial institutions, private forecasters and academic institutions. In 2005 the list of other forecasters included the European Union, the IMF, the OECD, United Nations DESA, CSFB, Dun & Bradstreet, Economist Intelligence Unit, Global Insight, IWH, JP Morgan, Kopint-Datorg and Vienna Institute.

Official revisions of inflation figures are relatively small and infrequent but they do occur. Estimates of annual average inflation are shown to be significantly revised over time, particularly in central Europe and the Baltic states. However, these estimates are not biased and the revisions have no significant impact on the empirical results. The results of tests based on official estimates with two years lag are therefore not presented in the paper but are available on request.

The presence of outliers is also analysed in this paper. The incidence of hyperinflation in Bulgaria in 1997 was identified as the most significant outlier. If included, it would have invalidated the statistical significance of many of the findings. As a result, this particular outlier has been eliminated from the empirical analysis. No other outlier had such an impact on the empirical results.

An important question relates to the use of the data in the formal ARIMA model. (Note that this is the only part of the analysis using the monthly data). One option is to use the full data set for estimation of model coefficients. The other option is to re-estimate the model for each year, using only the data available at the time of forecasting. In line with the best practice of forecasting (Armstrong, 2001), only the data available at the original time of the formation of the forecasts for the parameter estimation are used. This implies that for the first year of observations, only eight monthly data points are used. In this instance, annual average inflation is forecast by first forecasting the remaining four monthly data points and then calculating the annual average using these 12 data points. For the next year, 20 monthly data points are used, etc. Interestingly, even with such strict limitations on the model specification and parameter estimation, the ARIMA model performs relatively well for late within-year forecasts of annual average inflation in comparison with EBRD forecasts.

3. EMPIRICAL RESULTS

3.1 Basic statistical properties of forecast errors (bias, efficiency)

The first step in the empirical analysis of the forecast accuracy is the analysis of potential bias, that is, systematic deviation of the forecast from the outcome. The null hypothesis of no bias can be formulated as H_0: $\alpha = 0$ in $x_{i,t|s} - x_{i,t|r} = \alpha + u_{i.t}$ where $s, r = t-1, t-, t+, t+1, t+2$; $r<s$, and $u_{i.t}$ is an i.i.d. random term. It should be noted that the random term $u_{i.t}$ would follow a moving average process for forecasts more than one time period ahead (Holden and Peel, 1990). However, this is not the case for the forecasts assessed in this paper since these are only one-year-ahead (as well as within-year) forecasts.

Given that the 1990s proved to be exceptionally turbulent times, characterised by very high inflation for transition countries, one might expect to observe overshooting of inflation forecasts. (This is assuming forecasters adopted a cautious approach towards potential successes of macroeconomic stabilisation programmes in place.) A cautious approach to both growth and inflation forecasting was already identified in the EBRD (1996: 131-132) analysis of the within-year inflation forecasts in 1994 and 1995. EBRD inflation forecasts for these two years were found to be on the average more accurate, that is with smaller magnitudes of error, for central and eastern Europe as opposed to CIS, where inflation was high and more volatile, and thus more difficult to predict. Table 1 presents the test results for bias in inflation forecasting on the basis of the data for 1994-2005. For the whole sample, the null hypotheses of no bias in one-year-ahead, early within-year and late within-year forecasts could not be rejected, leading to the conclusion that on the whole, EBRD forecasts are unbiased.

Splitting the sample based on sub-regions and groups of countries with different exchange rate regimes (ERR)[6] yields a slightly different picture regarding forecast bias. There is no evidence of bias in SEE and CIS, as well as for the group of countries with flexible exchange rate regimes. However, for CEB and the group of countries with fixed exchange rate regimes, forecasts for all leads are significantly above the official estimate. Year-ahead forecasts of inflation in CEB display large positive bias to the tune of 1.7 percentage points, decreasing to approximately 1 percentage point for early within-year forecasts, and 0.2 percentage points for late within-year forecasts. This means that as the information domain expands and, in particular, more monthly inflation data become available, the magnitude of the bias in inflation forecasting in CEB reduces significantly. A similar conclusion also holds for the declining magnitude of the bias for the group of countries with a fixed exchange rate regime.

The positive bias in forecasts for all time leads observed in the CEB is also reflected in forecast revisions. There is empirical evidence of downward revisions in the CEB sub-region between late within-year and year-ahead forecasts as well as between late and early within-year forecasts. These results emphasise the importance of acquiring the information on monthly inflation rates and fully utilising such information, especially for late within-year forecasts of annual inflation.

[6] A fixed exchange rate regime (ERR) includes a currency board arrangement, fixed exchange rate, fixed exchange rate with a band, and crawling peg with a band. A flexible exchange rate regime includes a managed float and free float.

A particularly interesting issue is the comparison between the performance of EBRD forecasts and the performance of model-based forecasts. Naïve forecasts are shown to be unbiased for the whole sample, a surprising observation given the strong decline in the variability in the data. The naïve forecasts, as the simplest formal model-based forecasts, are biased only for CEB countries, with the magnitude of the bias exceeding that of EBRD forecasts. The late within-year forecast from the ARIMA model is biased only for CIS countries and countries with fixed exchange rate regimes, with a negative bias. Therefore, the ARIMA model forecast envisages faster disinflation and is below the actual outcome. However, for the CEB countries the late within-year forecast from the ARIMA model is unbiased, unlike the EBRD forecast.

Table 1 – Bias test results

	All countries	CEB	SEE	CIS	Flexible ERR	Fixed ERR
Forecast revisions:						
$inf_{t\|t+} - inf_{t\|t-1}$	-1.49	-1.44**	4.53	-3.95	1.09	-7.10
	(2.31)	(0.49)	(4.00)	(4.48)	(2.93)	(3.54)
$inf_{t\|t-} - inf_{t\|t-1}$	-0.70	-0.61	3.76	-2.50	1.51	-5.46
	(1.63)	(0.47)	(2.65)	(3.17)	(1.64)	(3.68)
$inf_{t\|t+} - inf_{t\|t-}$	-1.07	-0.74**	0.47	-1.91	-0.82	-1.63**
	(1.08)	(0.22)	(1.56)	(2.14)	(1.55)	(0.57)
Estimation error:						
$inf_{t\|t+2} - inf_{t\|t+1}$	-0.07	-0.00	-0.09	-0.10	-0.07	-0.06
	(0.07)	(0.01)	(0.08)	(0.15)	(0.10)	(0.05)
Forecast errors:						
$inf_{t\|t+1} - inf_{t\|t-1}$	-1.78	-1.71**	4.13	-4.21	1.03	-7.88*
	(2.40)	(0.48)	(4.36)	(4.64)	(3.05)	(3.67)
$inf_{t\|t+1} - inf_{t\|t-}$	-1.28	-0.95**	0.27	-2.11	-0.83	-2.26**
	(1.14)	(0.24)	(1.88)	(2.22)	(1.63)	(0.64)
$inf_{t\|t+1} - inf_{t\|t+}$	-0.21	-0.21**	-0.23	-0.20	-0.02	-0.63**
	(0.33)	(0.07)	(0.38)	(0.67)	(0.47)	(0.23)
$inf_{t\|t+1}$ – naïve for.	-10.81	-1.98**	-1.75	-20.25	-4.66	-24.34
	(5.93)	(0.49)	(4.83)	(12.01)	(3.92)	(16.87)
$inf_{t\|t+1}$ – model for.	0.74	-0.01	0.54**	1.33	0.86	0.48**
	(0.43)	(0.06)	(0.14)	(0.89)	(0.62)	(0.14)
Average inflation	16.8**	6.10**	15.82**	24.29**	19.84**	9.98**
	(2.38)	(0.55)	(4.95)	(4.33)	(3.30)	(2.02)
Number of observations	173	56	33	84	119	54

Source: EBRD.

Note: The table reports average errors over all years and within country groups. Statistically significant differences from 0 are denoted by * for the 5 per cent significance level and ** for the 1 per cent significance level. Robust standard errors are in brackets. Results based on official estimates with the two-year time lag are qualitatively similar in terms of statistical significance.

Tests for statistical significance of a positive bias (forecasts exceeding the outcome by a statistically significant margin) at a country / year level identify the following countries / years: Year-ahead forecasts: FYR Macedonia, Poland, 2002; early within-year forecasts: Czech Republic, Georgia, Latvia, Lithuania, Turkmenistan, 1998, 2001, 2002; late within-year forecasts: Albania, Armenia, Czech Republic, Lithuania; naïve forecast: Hungary, Poland, 1998, 2002; model: a negative bias: Albania, Armenia, Bulgaria, and 1998, and positive bias: Croatia.

Table 2 – Non-parametric Directional Analysis

	All countries	CEB	SEE	CIS	Flexible ERR	Fixed ERR
sign [inft|t+1 - inft-1|t]	0.37	0.33	0.33	0.40	0.38	0.33
sign [inft|t+1 - inft|t-1] = sign [inft|t+1 - inft-1|t]	0.71** (4.99)	0.71** (2.60)	0.70* (2.00)	0.72** (3.82)	0.72** (4.44)	0.71* (2.30)
sign[inft|t+1 - inft|t-] = sign [inft|t+1 - inft-1|t]	0.84** (8.97)	0.94** (6.60)	0.77** (3.05)	0.81** (5.70)	0.83** (7.27)	0.86** (5.27)
sign [inft|t+1 - inft|t+] = sign [inft|t+1 - inft-1|t]	0.94** (11.63)	0.96** (6.94)	0.93** (5.36)	0.93** (7.90)	0.94** (9.61)	0.94** (6.64)

Source: EBRD.

Note: The first row reports the fraction of observations where inflation increased between two consecutive years during the analysed period. The last three rows report the fraction of observations where the predicted increase / decrease of inflation was matched by an increase / decrease of actual inflation. That is, the sign of change in inflation was forecast correctly.

Pesaran and Timmermann (1992) statistics (with asymptotic standard normal distribution) are presented in brackets: ** denote results better than benchmark sign forecasts at the 1 per cent significance level and * denote results better than benchmark sign forecasts at the 5 per cent significance level.

The benchmark sign forecasts using Pesaran–Timmermann methodology are between 0.47 and 0.51. Results are based on 173 observations for all countries, 56 observations for CEB, 33 observations for SEE, 84 observations for CIS, 119 observations for countries with flexible exchange rate regimes and 54 observations for countries with fixed exchange rate regimes.

Table 2 presents the results of directional non-parametric analysis, that is, the analysis of the success in forecasting a *sign* of the change in annual average inflation rather than success in forecasting the inflation rate itself. The table shows that on average in about 60-70 per cent of cases inflation declined in two consecutive years. On the basis of the Pesaran-Timmermann test (Pesaran and Timmermann, 1992; Pesaran and Timmermann, 1995), it can be concluded that the EBRD forecasts had a relatively high success rate, compared with naïve forecasts, in correctly predicting the direction of a change in inflation in all main sub-regions. Correct predictions by the EBRD also increased with shortening lead of the forecasts from 70-72 per cent of cases for year-ahead forecasts to 93-96 per cent of cases for late within-year forecasts. The directional analysis also shows that the performance of the EBRD in correctly predicting the direction of change in the inflation rate does not differ substantially for countries with different exchange rate regimes.

Next, the efficiency of the forecasts is analysed. One simple test of efficiency is based on the view that the error term should follow a random walk process, and forecast revisions should not be autocorrelated. Given that only two forecast revisions are available, the analysis is based on a test of the null hypothesis H_0: $\beta = 0$ in $x_{i,t|t+} - x_{i,t|t-} = \alpha + \beta \cdot [x_{i,t|t-} - x_{i,t|t-1}] + u_{i.t}$ where $u_{i.t}$ is an i.i.d. random term across time and countries (note that country and time fixed effects are used for this test given the evidence of bias for certain countries and years). The result of this efficiency test is presented in the first row of Table 3. According to the test specified above, the EBRD forecast process is efficient, with the earlier forecast revisions not having any relation to the later forecast revisions.

Table 3 – Efficiency test results

	$inf_{t\|t-} – inf_{t\|t-1}$	Latest forecast	Exchange rate against US$	Exchange rate of US$ against euro	Constant	R-squared
$inf_{t\|t+} - inf_{t\|t-}$	0.26 (0.22)	-	-	-	1.48 (6.60)	0.22
$inf_{t\|t+1}$	-	0.07** (0.01)	0.57** (0.05)	0.19** (0.06)	5.67 (4.13)	0.93
Estimation error:						
$inf_{t\|t+2} - inf_{t\|t+1}$	-	-0.00 (0.01)	0.00 (0.00)	0.01 (0.01)	0.02 (0.06)	0.04
Forecast errors:						
$inf_{t\|t+1} - inf_{t\|t-1}$	-	-0.82** (0.08)	0.55** (0.06)	0.21* (0.09)	-1.25 (6.77)	0.90
$inf_{t\|t+1} - inf_{t\|t-}$	-	-0.63** (0.12)	0.45** (0.08)	0.17* (0.07)	0.37 (4.97)	0.71
$inf_{t\|t+1} - inf_{t\|t+}$	-	-0.02 (0.04)	0.06* (0.02)	0.05 (0.03)	-3.81 (2.46)	0.30
$inf_{t\|t+1}$ – naïve for.	-	-0.93** (0.01)	0.57** (0.05)	0.19** (0.06)	5.67 (4.13)	0.99
$inf_{t\|t+1}$ – model for.	-	-0.24* (0.11)	0.15* (0.06)	0.04 (0.03)	6.58 (3.82)	0.40

Source: EBRD.

Note: Statistically significant differences from 0 are denoted by * for the 5 per cent significance level and ** for the 1 per cent significance level. Robust standard errors are in brackets. The first equation is estimated using fixed effects for countries and years. Other equations are estimated using fixed effects for countries. The results are based on 173 observations. Results based on official estimates with the two-year time lag or with progress in transition and time instead of country and year dummies are qualitatively similar in terms of statistical significance.

However, even if the two consecutive revisions are not correlated, there may still be some efficiency improvements to be gained from the information available at the time of forecast formation. In particular, given that inflation in a given period is strongly correlated to inflation in the previous period, even if one accounts for the impact of exchange rate developments (see the second row in Table 3), one may test to what extent this information is incorporated in the forecast formation. It should be noted that the strong autocorrelation in inflation holds even if the exchange rate data are excluded from the regression, with only a small loss in explanatory power.

In order to test whether all available information is incorporated in the forecast, a null hypothesis of efficiency is specified as H_0: $\alpha = 0$ in $x_{i,t|s} - x_{i,t|r} = \nu + \alpha \cdot z_{i,t|r} + u_{i.t}$ where $r<s$, $u_{i.t}$ is an i.i.d. random term, and $z_{i,t|r}$ is the vector of indicators comprising all available information at time *r*, including the latest forecast in order to take into account the level of inflation rate. The alternative hypothesis is H_1: $\alpha > 0$, that is, a hypothesis of a positive relationship between the forecast error and the available information.

One approach, used in the literature, to define the vector $z_{i,t|r}$ assumes that all the available information at the time of forecasting is implicitly included in the latest available forecast. In this paper, however, the exchange rate of local currency against the US dollar, and the exchange rate of US dollar against the euro is also included. The justification for the selection of these additional explanatory variables, or potential determinants of inflation, is based on the fact that they are consistently significant for all main regions and also robust to the selection of analysed time period.

Concerning further potential determinants of inflation, the regression specification presented in the second row of Table 3 has been augmented by further variables such as GDP growth, broad money, domestic credit, interest rates, oil prices, fiscal balance, current account balance, capital account balance, FDI, and unemployment. However, none of these were included in the final model since the results were not robust either to the choice of linear versus log-linear model specifications, or to the selection of the sub-samples for one region or shorter time periods. The empirical results are also similar if one uses either inflation as a percentage change in the consumer price index or as a logarithm of the consumer price index.

The empirical results of the second version of efficiency test are presented in last five rows in Table 3. The empirical results are similar in terms of statistical significance of coefficients for lagged inflation for both specifications, with and without exchange rate variables. The only exception is the test of efficiency for the ARIMA model-based forecast where the coefficient for lagged inflation is not significant and the model forecast is thus efficient according to this test. This result is most likely driven by the specification of ARIMA model forecasts which are derived from the data on inflation in the past.

In the case of year-ahead and early within-year forecasts, the efficiency test suggests that strong autocorrelation in the inflation process is not fully incorporated in the forecasts, and this case persists even if one corrects for the impact of the exchange rate, which is a significant factor explaining the variation in inflation. Another way of reading this table is to say that even assuming perfect foresight for the exchange rates, the main conclusion, namely that the year-ahead and early within-year forecasts are inefficient, still holds. The results are similar if exchange rate variables are removed from equations, except for the ARIMA model forecast, and are available on request. It should be noted that for countries with fixed exchange rate regimes, the exchange rate is known in advance as long as the currency is not floated during the forecast period.

In the case of late within-year inflation, it is only the unobserved exchange rate of local currency against the US dollar which contains significant information useful for inflation forecasting. One potential recommendation to improve inflation forecasting is therefore to pay greater attention to exchange rate forecasts. Particularly, for the case of the EBRD which does not publish exchange rate forecasts, the clear recommendation is to start forecasting the exchange rate as well, even if this may initially only cover late within-year forecasts.

Tests of efficiency for naïve forecasts show that these benchmark forecasts are not efficient. In fact their inefficiency in terms of goodness of fit is worse than that of EBRD forecasts for all time leads. The late within-year forecast from the ARIMA model is efficient if the exchange rate is excluded from the test, but becomes inefficient if one assumes perfect foresight of the exchange rate. A potential extension of the present research agenda, going beyond the scope of this paper, would be to use a similar ARIMA forecasting model for the exchange rate and see if the forecasts would be better if inflation and the exchange rate are forecast as a system of two interacting economic variables.

Based on the efficiency tests presented above, one may also note a steep increase in efficiency measured by the goodness of fit measure (R^2), which declines from 0.90 for the year-ahead forecast efficiency equation to 0.71 and 0.30 for early and late within-year forecast efficiency equations, respectively. Therefore, the explanatory variables account for the progressively lower share of variability in forecast errors.

3.2 Forecast accuracy

The mean absolute forecast errors used throughout the paper to judge the accuracy of the forecasts, their development over time, and relation to the exchange rate, as well as time and progress in transition, are analysed in this section. Table 4 presents the mean absolute forecast revisions, estimation errors and forecast errors for the same groups of countries as tables in the previous section (the results for root-squared mean errors are similar and are available on request).

Table 4 – Mean absolute errors

	All countries	CEB	SEE	CIS	Flexible ERR	Fixed ERR
Forecast revisions:						
$\| inf_{t\|t+} - inf_{t\|t-1}\|$	10.57**	2.49**	8.3**	16.86**	11.51**	8.52*
	(2.15)	(0.39)	(3.78)	(4.04)	(2.70)	(3.47)
$\| inf_{t\|t-} - inf_{t\|t-1}\|$	6.80**	2.07**	5.45*	10.48**	6.75**	6.92
	(1.54)	(0.37)	(2.54)	(2.93)	(1.51)	(3.62)
$\| inf_{t\|t+} - inf_{t\|t-}\|$	5.57**	1.12**	3.76*	9.25**	6.95**	2.53**
	(1.00)	(0.19)	(1.42)	(1.89)	(1.42)	(0.50)
Estimation error:						
$\| inf_{t\|t+2} - inf_{t\|t+1}\|$	0.15*	0.02*	0.10	0.26	0.18	0.08
	(0.07)	(0.01)	(0.08)	(0.14)	(0.10)	(0.05)
Forecast errors:						
$\| inf_{t\|t+1} - inf_{t\|t-1}\|$	10.57**	2.53**	8.96*	16.58**	11.27**	9.06*
	(2.25)	(0.39)	(4.10)	(4.23)	(2.84)	(3.61)
$\| inf_{t\|t+1} - inf_{t\|t-}\|$	5.77**	1.30**	4.55*	9.23**	7.06**	2.94**
	(1.05)	(0.21)	(1.70)	(1.99)	(1.50)	(0.59)
$\| inf_{t\|t+1} - inf_{t\|t+}\|$	1.78**	0.38**	1.23**	2.93**	2.10**	1.06**
	(0.30)	(0.06)	(0.31)	(0.59)	(0.43)	(0.19)
$\| inf_{t\|t+1}$ – naïve for.|	18.66**	2.92**	11.71*	31.89**	15.55**	25.51
	(5.81)	(0.40)	(4.37)	(11.70)	(3.68)	(16.84)
$\| inf_{t\|t+1}$ – model for.|	1.67**	0.27**	0.73**	2.99**	2.11**	0.69**
	(0.42)	(0.05)	(0.12)	(0.84)	(0.60)	(0.13)
Number of observations	173	56	33	84	119	54

Source: EBRD.

Note: The table reports average errors over all years and within country groups. Statistically significant differences from 0 are denoted by * for the 5 per cent significance level and ** for the 1 per cent significance level. Robust standard errors are in brackets. Results based on official estimates with the two-year time lag are qualitatively similar in terms of statistical significance.

As there are significant differences in the level of inflation between the regions (see the second last row in Table 1 for the average inflation in different transition regions), an important hypothesis is related to forecast accuracy concerning potential regional differences. The comparison of forecast accuracy across regions can then be expanded to the analysis of forecast accuracy in relation to progress in transition, time, and other determinants of inflation. The empirical analysis in EBRD (1996) identified greater margins of error for the least developed part of the region – the CIS – compared with other transition countries. This finding, however, was based on only two years of observations for current year forecasts. Similarly, analysing short-term forecasts by the IMF between 1977 and 1994, Artis (1996) found larger forecast errors for developing countries compared with those for industrialised countries.

The empirical tests of differences between groups of countries confirm the *a priori* hypothesis of significant differences between main regions and between countries grouped by their exchange rate regimes. The forecast errors are smallest for CEB countries, where inflation is the lowest; the largest for CIS countries, where inflation is the highest. Forecast errors for SEE lie in between. The expected difference in forecast accuracy for countries with different exchange rate regimes is also documented in Table 4. Forecast accuracy is significantly better for countries with fixed exchange rate regimes. Furthermore, a comparison of the size of mean absolute forecast errors across different lead times shows that the largest forecast errors are observed in one-year-ahead forecasts, and the smallest in late within-year forecasts with the early within-year forecasts falling in between. Hence, forecast accuracy indeed tends to improve as more information becomes available. (Note that in the previous section forecast errors which could reach positive as well as negative values were analysed, while in this section absolute values of forecast errors were analysed.)

The accuracy of naïve forecasts is worse than that of EBRD forecasts in all regions. The forecast accuracy of the ARIMA model based on available monthly inflation data is better than that of the EBRD for late within-year forecasts, particularly for more advanced transition countries in the CEB and SEE regions and for countries with fixed exchange rate regimes. However, the differences between EBRD forecasts and ARIMA model forecasts are not statistically significant, unlike in the case of the differences between EBRD forecasts and naïve forecasts.

The relationship between the absolute value of forecast errors and the available information is also investigated in this section. This test is similar to the test analysed in the previous subsection which investigated the relationship between forecast errors (not in absolute values) and the available information. The null hypothesis is that forecast accuracy measured by the absolute value of forecast error does not depend on available information, H_0: $\alpha = 0$ in $| x_{i,t|s} - x_{i,t|r} | = \nu + \alpha \cdot | z_{i,t|r} | + u_{i.t}$ where $z_{i,t|r}$ is the vector of indicators comprising all available information at time *r*, including the latest forecast in order to take into account the level of inflation rate, *r*<*s*, and $u_{i.t}$ is an i.i.d. random term. The alternative hypothesis is $H_1 : \alpha > 0$, that is, a hypothesis of a positive relationship between the forecast accuracy and the available information. Similarly to the previous section, the exchange rate of local currency against the US dollar, and the exchange rate of the US dollar against the euro is used beside the latest available forecast of inflation as the indicators of available information relevant for the inflation forecasting.

The results of the regressions are presented in Table 5. Once again the interesting results are those related to the difference between results for year-ahead and early within-year forecasts on the one hand, and late within-year forecasts on the other hand. In the case of late within-year forecasts neither of the exchange rate variables is significant and nor is the level of inflation. This finding suggests that even a hypothetical perfect foresight of exchange rates would not have a statistically significant impact on the forecast accuracy, that is, mean absolute forecast errors. These results also hold for the accuracy of the late within-year forecasts from the ARIMA, which is constructed without the inclusion of exchange rates.

Table 5 – Relationship between exchange rate developments and forecast accuracy

	|Latest forecast|	|Exchange rate against US$|	|Exchange rate of US$ against euro|	Constant	R- squared
Forecast revisions:					
| $inf_{t\|t+}$ - $inf_{t\|t-1}$|	0.50**	0.37**	0.30**	-10.37*	0.86
	(0.08)	(0.05)	(0.07)	(4.12)	
| $inf_{t\|t-}$ - $inf_{t\|t-1}$|	0.44*	0.11*	0.11	-6.982	0.72
	(0.15)	(0.04)	(0.06)	(6.81)	
| $inf_{t\|t+}$ - $inf_{t\|t-}$|	0.24	0.17**	0.13**	-3.86	0.78
	(0.13)	(0.06)	(0.05)	(4.57)	
Estimation error:					
| $inf_{t\|t+2}$ - $inf_{t\|t+1}$|	0.00	-0.00	0.00	0.02	0.25
	(0.00)	(0.00)	(0.00)	(0.07)	
Forecast errors:					
| $inf_{t\|t+1}$ - $inf_{t\|t-1}$|	0.47**	0.44**	0.37**	-12.79*	0.85
	(0.10)	(0.07)	(0.10)	(6.00)	
| $inf_{t\|t+1}$ - $inf_{t\|t-}$|	0.15	0.25**	0.16**	-4.94	0.80
	(0.10)	(0.07)	(0.06)	(3.01)	
| $inf_{t\|t+1}$ - $inf_{t\|t+}$|	0.03	0.03	0.00	0.28	0.49
	(0.03)	(0.02)	(0.02)	(1.81)	
| $inf_{t\|t+1}$ – naïve for.|	0.87**	0.34*	0.51**	-15.29*	0.96
	(0.05)	(0.16)	(0.16)	(6.58)	
| $inf_{t\|t+1}$ – model for.|	0.01	0.03	-0.01	7.08	0.26
	(0.13)	(0.08)	(0.04)	(4.95)	

Note: Statistically significant differences from 0 are denoted by * for the 5 per cent significance level and ** for the 1 per cent significance level. Robust standard errors are in brackets. The equations are estimated using fixed effects for countries and years. Explanatory variables as well as the explained variables are in absolute values. The results are based on 173 observations. Results based on official estimates with the two-year time lag or with progress in transition and time instead of country and year dummies are qualitatively similar in terms of statistical significance.

Table 6 – Impact of progress in transition and time on forecast accuracy

<table>
<tr><th></th><th>|Latest forecast|</th><th>|Progress in transition|</th><th>|Time|</th><th>Constant</th><th>R -squared</th></tr>
<tr><td colspan="6">Forecast revisions:</td></tr>
<tr><td>$| inf_{t|t+} - inf_{t|t-1}|$</td><td>0.62**
(0.03)</td><td>-3.15
(3.36)</td><td>-0.59
(0.47)</td><td>10.64
(10.34)</td><td>0.64</td></tr>
<tr><td>$| inf_{t|t-} - inf_{t|t-1}|$</td><td>0.48**
(0.11)</td><td>0.35
(1.73)</td><td>-0.23
(0.33)</td><td>-1.96
(6.51)</td><td>0.65</td></tr>
<tr><td>$| inf_{t|t+} - inf_{t|t-}|$</td><td>0.36**
(0.09)</td><td>-0.33
(1.06)</td><td>-0.33
(0.30)</td><td>1.29
(4.80)</td><td>0.63</td></tr>
<tr><td colspan="6">Estimation error:</td></tr>
<tr><td>$| inf_{t|t+2} - inf_{t|t+1}|$</td><td>-0.00
(0.00)</td><td>-0.24
(0.16)</td><td>-0.01
(0.04)</td><td>0.88
(0.61)</td><td>0.02</td></tr>
<tr><td colspan="6">Forecast errors:</td></tr>
<tr><td>$| inf_{t|t+1} - inf_{t|t-1}|$</td><td>0.60**
(0.05)</td><td>-3.16
(3.96)</td><td>-0.50
(0.50)</td><td>10.61
(12.13)</td><td>0.55</td></tr>
<tr><td>$| inf_{t|t+1} - inf_{t|t-}|$</td><td>0.37**
(0.11)</td><td>-0.14
(1.15)</td><td>-0.23
(0.34)</td><td>0.50
(5.25)</td><td>0.57</td></tr>
<tr><td>$| inf_{t|t+1} - inf_{t|t+}|$</td><td>0.07**
(0.02)</td><td>-1.40**
(0.53)</td><td>-0.28*
(0.12)</td><td>5.70**
(2.10)</td><td>0.46</td></tr>
<tr><td>| $inf_{t|t+1}$ – naïve for.|</td><td>0.86**
(0.06)</td><td>3.11
(4.40)</td><td>-0.22
(0.62)</td><td>-13.27
(14.56)</td><td>0.93</td></tr>
<tr><td>| $inf_{t|t+1}$ – model for.|</td><td>0.04
(0.03)</td><td>-1.65*
(0.66)</td><td>-0.42**
(0.14)</td><td>7.35**
(2.49)</td><td>0.18</td></tr>
</table>

Source: EBRD.

Note: Statistically significant differences from 0 are denoted by * for the 5 per cent significance level and ** for the 1 per cent significance level. Robust standard errors are in brackets. Explanatory variables as well as the explained variables are in absolute values. The results are based on 173 observations. Results based on official estimates with the two-year time lag are qualitatively similar in terms of statistical significance.

Table 6 presents a different specification of the tests incorporating the full information set. Namely knowledge about a county's progress in transition, as well as time since the start of transition, are included. (It should be noted that there is sufficient variation between both indicators, time and progress in transition, to allow the inclusion of both variables at the same time.) The interesting results again relate to late within-year forecasts where both progress in transition and time are inversely and statistically significantly related to absolute values of forecast errors. This is true for both EBRD forecasts and ARIMA model-based forecasts. In other words, even accounting for the size of inflation – and thus the decline in the inflation rate over time – there is an improvement in forecast accuracy over time and there is also evidence of better forecast accuracy for more advanced countries in transition reforms in the case of the late within-year forecasts. The results on the improvements in time and better accuracy for more advanced transition countries hold also if both exchange rate variables are included as well. In such case the exchange rate variables are insignificant.

It is important to note that the significant improvement of ARIMA model forecast accuracy over time should be expected. This is because the model benefits from the availability of 12 more data points for each additional year. For the earliest full ARIMA-based forecasts only 20 monthly data are available (out of which only 8 are used because of the inclusion of 12 lag monthly inflation data). For the consequent ARIMA-based forecast of average annual inflation 32 monthly data are available (out of which only 20 are used), and so on.

One final point concerning the relationship between forecast accuracy measured by mean absolute forecast errors and determinants of inflation is that the goodness of fit (R^2) decreases with the lead of the forecast. That is the determinants of inflation show progressively lower shares of variability in the forecast accuracy. This is in line with earlier results related to efficiency of forecasts, namely that the EBRD inflation forecasts are more efficient for later forecasts.

3.3 Comparison of EBRD forecasts with other forecasters

Another issue to be analysed is the relative performance of EBRD forecasts compared with those by other institutions. As discussed above, the forecasts for transition countries by different institutions are not prepared contemporaneously and independently. Therefore, the results may reflect largely the impact of time difference between the formation of forecasts by different institutions.

Table 7 – Average differences between EBRD and other forecasts

	All countries	CEB	SEE	CIS	Flexible ERR	Fixed ERR
Forecast revisions:						
$inf_{t\|t+} - inf_{t\|t-1}$	3.19 (2.08)	-0.33 (0.51)	-1.14 (2.14)	7.26 (4.15)	2.73 (2.79)	4.17 (2.62)
$inf_{t\|t-} - inf_{t\|t-1}$	2.29 (2.62)	0.28 (0.44)	3.31 (1.92)	3.23 (5.35)	3.16 (3.56)	0.41 (3.13)
$inf_{t\|t+} - inf_{t\|t-}$	-0.79 (1.71)	-0.58 (0.45)	-3.77 (2.73)	0.21 (3.34)	-3.00* (1.44)	3.96 (4.36)
Forecast errors:						
$inf_{t\|t+1} - inf_{t\|t-1}$	2.87 (2.11)	0.40 (0.28)	0.81 (0.77)	5.34 (4.35)	1.34 (2.80)	6.18* (2.77)
$inf_{t\|t+1} - inf_{t\|t-}$	0.60 (1.66)	0.11 (0.29)	-2.45 (2.13)	2.11 (3.31)	-1.80 (1.31)	5.77 (4.34)
$inf_{t\|t+1} - inf_{t\|t+}$	1.50** (0.57)	0.52 (0.32)	1.40 (1.60)	2.18* (0.96)	0.87 (0.69)	2.90** (0.98)
Number of observations	173	56	33	84	119	54

Source: EBRD.

Note: Robust standard errors are in brackets. The data are constructed by first calculating error terms, then taking differences between the EBRD and other errors, and finally by averaging the results for the respective region. Note that in the case of forecasts, the difference is equal to the difference between other forecasts and EBRD forecasts. (For example, a positive number simply reflects higher other forecasts on average, so there is no difference if estimates for one or two years later are used.)

Table 7 displays the empirical results for the comparison of average differences between forecasts by the EBRD and those by other forecasters. Forecast errors of other forecasters are statistically significantly above the EBRD for several groups of countries, although this is the case mostly for late within-year forecasts. Late within-year forecast errors of others are on average 1.5 percentage points higher than those of the EBRD. This is most likely driven by the fact that compared with those of the EBRD, other forecast errors are approximately 2.2 percentage points higher for the CIS. Furthermore, other forecast errors are 2.9 percentage points higher than those of the EBRD for countries with fixed exchange rate regimes.

Table 8 – Average differences between absolute errors of EBRD and other forecasters

	All countries	**CEB**	**SEE**	**CIS**	**Flexible ERR**	**Fixed ERR**
Forecast revisions:						
$\|inf_{t\|t+} - inf_{t\|t-1}\|$	-3.83 (2.01)	0.18 (0.30)	-3.26 (1.87)	-6.73 (4.08)	-3.51 (2.74)	-4.54 (2.37)
$\|inf_{t\|t-} - inf_{t\|t-1}\|$	-1.21 (2.35)	0.69 (0.36)	2.29 (1.93)	-3.83 (4.76)	-1.93 (3.14)	0.33 (3.04)
$\|inf_{t\|t+} - inf_{t\|t-}\|$	-0.92 (1.57)	-0.20 (0.41)	-4.23 (2.67)	-0.13 (3.04)	0.67 (1.44)	-4.36 (3.83)
Forecast errors:						
$\|inf_{t\|t+1} - inf_{t\|t-1}\|$	-3.12 (1.71)	-0.22 (0.22)	-1.15 (0.60)	-5.86 (3.51)	-2.08 (2.18)	-5.40* (2.66)
$\|inf_{t\|t+1} - inf_{t\|t-}\|$	-1.77 (1.43)	-0.20 (0.29)	-2.32 (2.13)	-2.60 (2.82)	-0.04 (0.77)	-5.48 (4.16)
$\|inf_{t\|t+1} - inf_{t\|t+}\|$	-2.51** (0.50)	-0.74* (0.29)	-4.08** (1.41)	-3.05** (0.82)	-2.32** (0.59)	-2.92** (0.95)
Number of observations	173	56	33	84	119	54

Source: EBRD.

Note: Robust standard errors are in brackets. The data are constructed by first calculating error terms in absolute values, than taking differences between the EBRD and other errors in absolute values, and finally by averaging the results for the respective region.

Tests for statistically significant better forecast accuracy of the EBRD identify the following countries / years: Year-ahead forecasts: none; early within-year forecasts Poland, Slovenia, 2003; late within-year forecasts: Armenia, Kyrgyz Republic, Latvia, Lithuania, Turkmenistan, 2000, 2001, 2002, 2003.

Finally, Table 8 presents the results of the comparison of EBRD and other forecasts in terms of mean absolute forecast errors. In other words, the Table 8 shows forecast accuracy (for example, in the case of late within-year forecast errors the comparison is based on the difference: $|inf_{t|t+1} - inf_{t|t+(EBRD)}| - |inf_{t|t+1} - inf_{t|t+(others)}|$). Hence, a negative value of the analysed statistic means that on average EBRD forecast accuracy is better than that of other institutions.

A close inspection of Table 8 reveals that the most significant differences are in the case of late within-year forecasts. EBRD forecast errors are smaller for late within-year forecasts for all country groupings, ranging from 0.7 percentage points for CEB countries, 2.5 percentage points for all transition countries, and more than 4 percentage points for SEE countries. Earlier, we established that the availability of monthly inflation data considerably increases forecast efficiency. Therefore, the finding of EBRD forecasts based on only a few more data points of monthly inflation being substantially more accurate than forecasts of other forecasters again emphasises the need for timely data collection and use of all the available information at the time of forecasting, including the past forecast errors.

4. SUMMARY AND CONCLUDING REMARKS

The paper presents a detailed statistical analysis of the performance of EBRD inflation forecasts for 25 transition countries between 1994 and 2005. EBRD forecasts are shown to be unbiased, except for the countries in central Europe and the Baltic states and for countries with fixed exchange rate regimes.

The evidence on the efficiency of EBRD forecasts is mixed. While the efficiency tests based on forecast revisions supports the hypothesis of efficient forecasts, the tests based on the relationship between forecast errors and available information at the time of forecasting show that only late within-year forecasts are efficient, even if one assumes perfect foresight and controls for the impact of the exchange rate. In addition, only late within-year forecasts display an improving time trend for forecast accuracy, and a strong relationship with progress in transition.

The choice of the exchange rate regime has a strong impact both on the level and the forecast accuracy of inflation. Countries with fixed exchange rate regimes have lower inflation and forecasts for these countries are more accurate than forecasts for countries with flexible exchange rates. There is a ratio of 1:2 between both average inflation and mean absolute forecast error for the two groups of countries.

Mean absolute forecast errors, as a measure of forecast accuracy, are shown to be largest for the least advanced transition countries and smallest for the most advanced transition countries. This reflects a similar link between progress in transition and inflation rate. It is also shown here that forecast accuracy increases with the expansion of the information domain, that is, the availability of monthly inflation rates.

The performance of naïve forecasts, assuming annual average inflation does not change for the forecast year from the previous year, is worse compared with EBRD forecasts based on all measures used in the paper. However, the performance of late within-year forecasts from the ARIMA model, using available monthly inflation data, is better than the performance of EBRD forecasts by 0.1 percentage point on average. The difference, however, between the two sets of forecasts is not statistically significant. ARIMA forecasts are efficient, improve with time as more data becomes available, and perform better with progress in transition.

This paper also shows that the accuracy of EBRD forecasts is similar to that of other forecasters for year-ahead and early within-year forecasts, but better for late within-year forecasts. On average, late within-year EBRD forecasts are to the tune of 2.5 percentage points more accurate than forecasts by other institutions. This difference ranges from 0.7 percentage points for CEB countries to 4.1 percentage points for SEE countries and to 3.1 percentage points for CIS countries. This finding is most likely due to differences in the time frames of the preparation of forecasts by different institutions.

The findings of this paper have three main implications for inflation forecasting for transition countries:

- The strong link between exchange rate and inflation emphasises the importance of assessing the impact of exchange rate regimes as well as potential exchange rate movements while preparing inflation forecasts.
- The steep improvements in forecast efficiency and accuracy with the expansion of information domain stress the importance of using the most recent monthly inflation data when forming annual forecasts.
- The good performance of the formal ARIMA model of monthly inflation data suggests the usefulness of model-based forecasts on a systematic basis. At the very least, consistency of judgemental forecasts should be checked with the past behaviour of a forecast time series using the highest frequency data available.

The present paper has several potential extensions:

- One may focus in more detail on the relationship between forecast accuracy and determinants of inflation in transition countries, building a complex model of country level determinants of inflation while allowing for interaction between individual countries through their current and capital accounts.
- A more sophisticated ARIMA model than the one presented in this paper could be constructed, which not only covers additionally the early within-year and year-ahead forecasts, but also includes forecasts of exchange rates using monthly data. Potentially, such a model could also allow for different model specifications for individual countries.
- An analysis of forecast accuracy of all variables forecast by the EBRD for transition countries could be undertaken, allowing for interaction between all forecast variables.

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