Small, Simple and Fine: The OeNB Forecast Model for CESEE[1]

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Abstract
This short paper describes the new forecasting tool used by the OeNB to derive near-term forecasts on GDP and imports for five CESEE countries (Bulgaria, Croatia, Czech Republic, Hungary, and Poland). An error correction (EC) model is estimated separately for each country by means of seemingly unrelated regressions. Each country-specific macro model consists of 6 structural cointegration relationships modelling private consumption, investment, exports, imports, nominal exchange rate and nominal interest rates by an augmented Taylor rule. Based on quarterly data, starting from Q1 1995, we derive forecasts for GDP and imports from this model. In line with the experience of many other models, the forecasting performance is not superior to a simple AR-model. Given the dynamic nature of the transition process as well as the limited availability and, in some cases, also quality of data, our structural model for CESEE countries performs fairly well and further gains in forecasting accuracy are expected as data accumulates and its quality improves.

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1) The need for forecasts on CESEE from the Austrian perspective

With long-standing economic relationships between Austria and many Central Eastern and South Eastern European economies (CESEEs), there is a great interest for qualified forecasts on economic developments in this region. Timely and reliable estimates on future economic developments in these countries are of importance for the OeNB given the strong economic linkages between Austria and CESEE countries in terms of trade and FDI flows. This implies firstly, that developments in this region feed into the forecast of the Austrian economy as an important external assumption. Secondly, not only Austrian investors in general, but in particular all relevant Austrian commercial banks are strongly involved in CESEE countries and hence the financial market analysis division also draws back on these regional forecasts in their regular stress-testing exercises. As a further aspect, the OeNB offers the forecasts as an additional input into the agreement upon external assumptions in the first round of the ECB's biannual macroeconomic projection exercise (BMPE).

The Oesterreichische Nationalbank has delivered expert-based judgments, partly supported by regression analyses and elasticity estimates, for the economic prospects of three countries, the Czech Republic, Hungary and Poland, for internal uses and as an input into the BMPE over a long period of time. The existing set of available tools for forecasting economic developments in CESEE has now been expanded by a more formal approach. Starting in April 2009, the informed expert judgments are for the first time supported further by a simple macroeconomic model which is estimated in a multivariate time series framework. More precisely, we are estimating an error correction (EC) model by means of seemingly unrelated regressions for each country separately. The model serves foremost as a consistency and plausibility check of the expert judgement which continues to play an important role in the OeNB-forecast. The

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projections are published bi-annually in the Focus of European Economic Integration (issues Q2 and Q4), together with the Bank of Finland's forecast on Russia. The small range of countries reflects the initial focus on the three largest (in terms of nominal GDP) Central European countries as well as on Russia (given its strategic importance) and is gradually being expanded. In a first step, Bulgaria and Croatia have been added. Romania will follow as soon as the necessary time series fulfil some basic requirements, which are basically related to their length.[2] Given the comparably weaker economic ties between Austria and the Baltic States we decided against the development and maintenance of country specific models for these three countries. On the other hand, there is a large interest in the Croatian economy, which is why we have developed a separate country model for Croatia.

In the next section, we describe the forecasting model. Our data set and the time series properties of the relevant variables, necessary for our EC model, are discussed in section 3, while section 4 is devoted to the evaluation of the out-of-sample model performance in a historic perspective. Finally, section 5 concludes.

3) A small, simple and fine macroeconomic model for CESEE countries

Our forecasting tool is a country-specific macro model whose core part consists of 6 structural cointegration relationships. The structure of the model is a simple aggregate demand – aggregate supply model (AS-DS) in the vein of Merlevede et al (2003). Keeping our model as simple as possible we focus on private consumption, investment, exports, imports, the nominal exchange rate and the nominal interest rate. These variables are modelled within the framework of a small, predominantly Keynesian macro model, including some neoclassical features (such as the dependence of private consumption on interest rates). The interest rate itself is estimated by an augmented Taylor rule. The core structure of the model is given by the structural equations (1) – (6) below:

$$c\_priv = \alpha_1 * gdp + \alpha_2 * (ir - cpi) \quad (1)$$
$$inv = \beta_1 * gdp + \beta_2 * (ir - ppi) \quad (2)$$
$$\exp = \gamma_1 * (er * pc\_ea / pc) + \gamma_2 * gdp\_eu + \gamma_3 * \exp\_eu + \gamma_4 * gdp \quad (3)$$
$$imp = \delta_1 * gdp + \delta_2 * (er * pc\_ea / pc) \quad (4)$$
$$er = \kappa_1 * (ir - ir\_ea) + \kappa_2 * (m3 - m3\_ea) + \kappa_3 * (gdp / er - gdp\_ea) \quad (5)$$
$$ir = \phi_1 * cpi + \phi_2 * gdp + \phi_3 * er + \phi_4 * ir\_ea \quad (6)$$

The underlying assumption of using the cointegration framework is that the variables of interest are linked by a long run relationship for each of the six equations listed above. Private consumption (c_priv) is assumed to be in an equilibrium relationship with economic output (gdp) and nominal interest rates deflated by consumer prices (ir-cpi). In the same vein, the investment equation is modelled as a function of GDP (gpd) and interest rates this time deflated by producer prices (ir-ppi). Exports depend primarily on own GDP and the real

[2] For the time being, real data for quarterly GDP and its components are only available from the first quarter of 2000 and as such, the time series are too short for our analysis. Given negative growth rates of GDP throughout the years 1997-2000, an imputation of these data, using available yearly price indices does not seem to be advisable. Further, enlarging the time series to include this drastic recession would probably not be helpful for the derivation of long-run structural parameters, which we need to estimate out of the sample and which serve as the basis for our forecasts. Thus, the OeNB forecast for Romania is based on a broad range of available information from various sources and expert judgement,

exchange rate (er*pc_ea/pc).[3] While the latter captures the country's competitiveness on the world markets the former is ment to approximate the country's export supply capacities. Additionally we introduce GDP (gdp_eu) and exports of the EU 27 (exp_eu). The former is supposed to control for the foreign demand for a country's exports justified on the grounds that a lion's share of the countries' exports goes to the EU.[4] In contrast, exports of the EU 27 are meant as a proxy for the global trade volume, thus capturing trends on world trade which are common to all countries. The import equation is modelled more parsimoniously relating the country's imports to GDP approximating domestic demand and to the real exchange rate. In the spirit of Merlevede et al (2003) we model the nominal exchange rate as a function of interest rates differentials with respect to the euro area (ir-ir_ea), money supply differentials (m3-m3_ea) and GDP differentials (gdp/er – gdp_ea). We slightly deviate from Merlevede et al (2003) in the case of the nominal interest equation. Here we use an augmented Taylor rule incorporating inflation (cpi), the nominal exchange rate (er) and nominal interest rates in the euro area (ir_ea). GDP is introduced as an additional term to capture the cyclical stand of the economy, which is traditionally measured by the output gap. Furthermore, lack of reliable data impedes the use of an unemployment gap.

This core model is adapted for each country to give the best fit to the data by dropping highly insignificant parameters in the system, which also helps to save degrees of freedom. Thus, we arrive at five models with small country-specific nuances. Due to the currency board arrangement in Bulgaria a more far reaching deviation from the core model is used in this case: Exchange and interest rate are assumed, respectively, to be constant and to follow an AR process.[5]

To check whether the cointegration assumption is justified and whether the long-run relationships are well specified we carry out a cointegration test. In the test, we take account of the possible endogeneity among the variables in the form of a simultaneity bias by using the dynamic ordinary least squares (DOLS) method developed by Stock and Watson (1993) for our cointegration tests. This test essentially boils down to estimating the long-run equilibrium relationship extended by lags and leads of all included variables by OLS and testing the deviations from the long-run relationship (i.e. the residuals) for stationarity. The results are presented in table 1.[6] The table displays the p-values on a unit root test of the residuals obtained in the DOLS regression. All of the DOLS-residuals are stationary on the 5% significance level suggesting that both the cointegration assumption and the model specification are correct. In economic terms, each long-run relationship identifies the determinants of long-run growth of the respective GDP component in our model. The presence of these cointegrating relationships implies the stability of the investment-, consumption-, export- and import- ratio in GDP, augmented with other variables. This further implies common stochastic trends in our variables.[7]

[3] Here, "pc" refers to the domestic consumer price index and "pc_ea" to the one of the euro area.
[4] We have alternatively tried to use imports of the EU27, however the explanatory power of the equation was greater when using GDP.
[5] In the future, we envisage to model interest rates similar to the specification used by the Bulgarian National Bank. We would like to thank Emilia Penkova for pointing out this possibility to us.
[6] Due to degree of freedom constraints, we used only 1 lag and 1 lead in the DOLS-estimations.
[7] Given the short- to medium-term nature of our forecasts, we do not think that demographic change plays an important role.

Table 1: P-values of the Engle-Granger test on stationarity of DOLS-residuals

	BG	CZ	HR	HU	PL
Consumption	0.0002	0.0005	0.0000	0.0203	0.0001
Exchange Rate	-	0.0466	0.0235	0.0062	0.0155
Exports	0.0000	0.0000	0.0000	0.0008	0.0000
Imports	0.0000	0.0009	0.0206	0.0368	0.0000
Investment	0.0002	0.0239	0.0138	0.0002	0.0059
Interest Rate	-	0.0000	0.0004	0.0000	0.0026

Having successfully completed the necessary tests for non-stationarity in the series and cointegration in the long-run equilibrium relationships we proceed to estimate the entire system of equations. Each of the six structural equations sketched out in equations (1) – (6) is specified in the form of an error correction model,

$$\Delta y_t = a\Delta y_{t-1} + b'\Delta X_{t-1} + \gamma(y_{t-1} - \alpha - \beta' X_{t-1}) + \varepsilon_t \qquad (7)$$

with γ denoting the error correction parameter. This parameter reflects how fast the cointegrated (i.e. co-trending) variable returns to its long run relationship once it is out of equilibrium.

All other exogenous variables (i.e. those variables not appearing on the left hand side in equations (1) – (6)) entering the model are assumed to follow simple AR(1) processes which is the least costly modelling way in terms of lost observations and degrees of freedom. However, it should be noted that the results do not significantly change if the optimal lag-length of the AR processes is chosen according to standard information criteria. This is probably due to the fact that the optimal lag length proved to be 1 in most cases anyway.[8]

This system of six structural equations and eleven AR processes[9] is then estimated by means of seemingly unrelated regressions to account for correlations between the model components through the unobserved correlation in the error terms. This is meaningful both from an economic point of view (to account for shocks common to all variables such as business cycle fluctuations, etc.) and from a statistical point of view (the joint estimation increases statistical efficiency). To be precise, we estimate only 8 of the ten AR(1) processes, while we update time series for the EU27 (GDP and exports) with the most recent available ECB-forecasts in order to qualitatively improve our baseline forecast. The estimated parameters in the model mostly behave well. In table 2 we report the most important coefficients on the EC-terms all of which but one show up with the expected, in most cases significant, negative sign. Instances with no significance on this parameter occur sometimes in the investment equation, in the exchange rate equation for Hungary and the interest rate equation for the Czech Republic. In Croatia, we have two instances were the adjustment parameter exceeds one in absolute value, which does not pose a statistical problem, but implies some overshooting in the adjustment.

[8] Given the limited sample size the maximum number of possible lags is restricted to 4.

[9] For the following exogenous variables: inflation in euro area, inflation in resp. country, money supply in euro area, money supply in resp. country, GDP in EU27, exports in EU27, GDP in euro area, interest rates in euro area, producer prices, stock changes, and public consumption.

The structural parameters obtained through the seemingly unrelated regression are then used to derive 1- to 8-steps ahead dynamic forecasts. Our GDP forecast is derived as the sum of the forecasts for the individual components.

Table 2: Adjustment Parameters associated to the Equilibrium Correction Terms

	BG	**CZ**	**HR**	**HU**	**PL**
Consumption	**-0.5111**	**-0.2128**	**-1.1947**	**-0.1624**	**-0.3434**
t-stat	(-6.4058)	(-3.9939)	(-5.16507)	(-2.7675)	(-3.6699)
p-val	0.0000	0.0001	0.0000	0.0058	0.0003
Exchange Rate	**-**	**-0.1240**	**-0.3317**	-0.1076	**-0.0919**
t-stat	-	(-3.3875)	(-5.0211)	(-1.5885)	(-2.2661)
p-val	-	0.0007	0.0000	0.1126	0.0237
Exports	**-0.2562**	**-0.3442**	**-1.3453**	**-0.3154**	**-0.6410**
t-stat	(-3.2958)	(-2.7979)	(-10.0714)	(-4.0128)	(-5.5352)
p-val	0.0010	0.0053	0.0000	0.0001	0.0000
Imports	**-0.3229**	**-0.1185**	**-0.1606**	-0.0486	**-0.3512**
t-stat	(-4.6264)	(-1.6962)	(-1.9514)	(-1.4822)	(-3.8360)
p-val	0.0000	0.0902	0.0514	0.1387	0.0001
Investment	**-0.6644**	**-0.2240**	-0.0868	-0.1476	0.1015
t-stat	(-4.9568)	(-2.9369)	(-1.0254)	(-1.5048)	(1.4552)
p-val	0.0000	0.0034	0.3055	0.1328	0.1460
Interest Rate	**-**	-0.1607	**-0.3920**	**-0.4362**	**-0.1281**
t-stat	-	(-1.5577)	(-3.2282)	(-4.4106)	(-2.7646)
p-val	-	0.1197	0.0013	0.0000	0.0058

Note: Parameters significant on the 10% level highlighted in bold

3) Description of the database

For each country we are using quarterly data on GDP and its components, which we take from Eurostat. Our sample ranges from the Q1 1995 or, in case of Bulgaria, from Q1 1998 to the most recent quarter for which data are published. In cases where the time series provided by Eurostat do not reach back to the beginning of 1995, we have completed our data set with monthly data from the Vienna Institute for International Economic Studies and from national sources. Thus, we estimate the structural equations in the model using a sample supposedly unbiased by the strong recession which followed after the fall of communism. Apart from the most recent crisis, there are no major obvious structural breaks in the estimation sample, which should provide for rather stable coefficients on our variables of interest.[10] We use real data taking logs, based on the chain-link method employed by Eurostat. All series are seasonally detrended using the Census X12 method.[11]

Table 3 provides a list of all variables used in the model along with a short description of their time-series properties. At the heart of our empirical framework is the concept of cointegration. Hence we aim at modelling long-term equilibrium relationships among the economic variables of interest. In particular we estimate the long run relationships of economic variables by means of an error correction (EC) model. The necessary prerequisite for cointregrated series is that they are integrated of the same order d>0. In macroeconomics, this order of integration is typically 1 and the time series is said to have a unit root in levels. Thus, in a first step we test for this form of non-stationarity using the augmented Dickey Fuller test.

[10] EU membership and its economic impact on the countries covered in this note can be considered a smooth process and is not what is called a „structural break" in the time series literature.

[11] We chose this method as it is also used by Eurostat to de-seasonalize the EU and EA series.

The results of these tests are summarized in table 3 for all countries. Almost all variables have a unit root indeed with few exceptions, these being ppi inflation in most countries and the real interest rate in Bulgaria and Hungary. For some of these series the test does reject the null of a unit root, to be sure, a visual inspection however suggests that non-stationarity is a more plausible assumption. Particularly the inflation paths in the Czech Republic, Hungary and Poland show a rather strong disinflationary trend at the beginning of the sample. In fact, most of the applied econometrics literature does indeed treat these trend-stationary series as unit root processes (see the contributions by Enders and Granger 1998 and Engle and Granger 1991). Other series which are clearly stationary such as the nominal exchange rate or interest rates in Bulgaria due to the currency board arrangement or stock changes in Poland are less problematic in our context as they do not enter these countries' cointegration equations as endogenous variables. Hence, overall, we can conclude that the time series at large fulfil the required necessary properties for our econometric model.

Table 3: List of variables included in the model and summary of their time-series properties.

Variable name	**BG**	**HR**	**CZ**	**HU**	**PL**	**EU/EA**
GDP, constant prices	+	+	+	+	+	n.u.
Private consumption	+	+	+	+	+	n.u.
Public consumption	+	+	+	+	+	n.u.
GFCF, constant prices	+/x	+	+	+	+	n.u.
Exports, constant prices	+	+	+	+	+	+
Imports, constant prices	+	+	+	+	+	+
Stock changes, constant prices	+	+	+	+	z	n.u.
Nominal exchange rate (local currency/euro), period average	z	+	+	+	+	n.u.
Real exchange rate, CPI deflated	+	+	+	+	+	+
Real exchange rate, PPI deflated	+	+	+	+	+	+
Nominal 3M interbank deposit rate, period average	+	+	+	+	+	+
Real 3M interbank deposit rate, CPI deflated	z	+	+	z	+	+
Real 3M interbank deposit rate, PPI deflated	z	z	+	z	+	+
PPI index	+	+	+	+	+	+
PPI inflation, y-o-y	z	z	+/z	+/z	+/z	
CPI index	+	+	+/z	+	+	+
CPI inflation, y-o-y	z	+	+	+/z	+/z	+
M3, EUR mn	+	+	+	+	+	+

Note: '+' says that a series is I(1). 'z' denotes that a unit root can be rejected, i.e. the corresponding time series is I(0); 'x' stands for a trend stationary series. Depending on the economic meaning we either used EU or euro area (EA) data ('n.u.' stands for 'not used in our model').

4) Model validation

To evaluate the forecasting power of our model with respect to precision and direction of change we carry out the following exercise: we cut out a window of eight quarters at the beginning of the sample and use the remaining data to estimate simultaneously the parameter values for our error correction model on the one hand, and a parsimonious benchmark model in which all variables are modelled as simple AR(1) processes on the other. Using these parameter estimates, we produce an out-of-sample forecast with both models – the structural model and the AR-benchmark model - for 1 to 8 quarters for the eight-quarter-window previously cut out. The forecasting errors are computed by comparing both sets of forecasts with actual realisations.

In a rolling regression framework, the eight-quarter-window is subsequently moved one quarter ahead, the models are re-estimated and new out-of-sample forecasts are obtained for the shifted eight-quarter-window. This procedure could in principle be repeated until the window reaches the end of the sample and all available observations are used to estimate the model parameters. However, in order not to spoil the model estimation we prefer to exclude the recent crisis episode. Therefore, we let the eight-quarter-window wander across the sample until its beginning reaches Q3 2008 so that the last model parameters are estimated using data only up until Q2 2008.

For each of the eight forecasting horizons we compute three quality indicators to evaluate the forecasting ability of our EC model: the hit rate, an indicator of the growth rate's sign matching and the Diebold-Mariano test (a description of these indicators is given in the appendix). The results - reported in the five country panels of table A1 for three selected variables: the GDP, imports and the exchange rate – are rather mixed. Beginning the analysis with the hit rate some striking observations may be noticed. Firstly, the hit rate is particularly high for Poland, Czech Republic and Hungary, while it is significantly lower for Croatia and rather poor for Bulgaria. Secondly, except for the Czech Republic and Bulgaria the hit rate is typically slightly higher for GDP than for imports, and is substantially lower for the exchange rate. Nevertheless, against the backdrop of the well documented fact that predicting exchange rate is an extremely challenging issue the hit rate for the exchange rate is still comparatively high, especially in case of the Czech Republic. Similar conclusion as for the hit rate may be drawn also for the indicator of growth rates' sign matching, although there the difference between variables and countries is much less pronounced. Moreover, the sign of the forecast growth rates tends to coincide with the actual ones rather at shorter horizons.

Furthermore, results of the Diebold-Mariano test show the rather moderate forecasting performance of the EC model. Our structural model seems to significantly outperform the benchmark AR-model only when forecasting the exchange rate for Poland (at most horizons), the GDP in Hungary (4 to 8 quarters ahead) and imports in the Czech Republic (in the medium run). In some cases the simple benchmark model has a significantly better forecasting ability than our structural model, particularly at some horizons for GDP in Poland and Croatia and for both, the GDP and imports in Bulgaria. In all other cases both models show equal forecasting power in the statistical sense.

Although the flexible design of our model allows some country specific adjustments which might still leave some scope for improvement in the predictive power, the mixed results of the evaluation exercise most likely reflect the dynamic nature of the transition process as well as the limited availability and, in some cases, also quality of data. This can be best seen by comparing forecast results for Bulgaria with those of the other peers with the latter ones outperforming forecasts for Bulgaria by a wide margin. Against this backdrop our structural model for CESEE countries performs fairly well and further gains in forecasting accuracy are expected as data accumulates and its quality improves.

5) Conclusions

Given strong economic linkages between Austria and the Central and Eastern European region, well-founded, timely and reliable estimates on future developments of fundamental macroeconomic variables are highly relevant in general and for the OeNB in particular.

Therefore, in this paper we have presented a simple, country-specific macroeconomic error correction model estimated in a multivariate time series framework for five CESEE countries.

With this model, we add an additional tool to forecasting short-term macro economic developments in CESEE, a region for which model-based forecasts other than from national institutions are still rare. The model is kept rather simple and well specified from a statistical point of view. Despite its simplicity, it is not yet superior to even more simple time series models in terms of forecasting ability. This may be related to the dynamic development the transition countries have been experiencing in the last years as well as to data limitations (both in terms of shortage and quality of available time series. On the other hand, we intentionally wanted to include also economic reasoning in our model, and thus did not opt for a pure time series model.

Despite the fact that there is still scope for improvement in the forecasting power, we believe that our simple macro model is superior to alternative econometric forecasting tools for several reasons. To begin with, our model is a simple and flexible framework for obtaining forecasts of GDP and its components. It relies exclusively on estimated parameters and therefore avoids uncertainty associated to calibration based on deep parameters which are not country-specific. This is particularly relevant for CEE-countries where part of the transition dynamics is systematically interpreted as an out-of-equilibrium adjustment. We can readily include country-specific factors based, for instance, on monetary policy strategies (exchange rate regimes, inflation targeting, etc.). Yet another advantage of this framework is the fact that it easily allows to make some of the variables exogenous if it is necessary so as to incorporate information which emanates from forecasts outside the model framework or from expert assessments. Finally, due to its auto-regressive components the model reacts extremely fast to exogenous shock, albeit at the cost of mostly missing turning points. Moreover, as has been documented in the literature the much simpler and less resources-consuming AS-DS-models often outperform even sophisticated DSGE-models in terms of predictive power and accuracy (see for instance Colander et al. 2008, Rubaszek and Skrzypczyński 2008, Wang 2008).

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Appendix: Model validation

The following three measures are used to evaluate the forecasting ability of our model:

i) the Diebold-Mariano test (Diebold and Mariano 1995) of which the null hypothesis is that the forecasting ability of the EC model and the benchmark AR model are equal. In other words, it tests whether the difference between the root mean squared error (RMSE) of the EC model and the benchmark AR model is statistically different from 0. The RMSE is a measure of the forecasts accuracy and is defined as

$$\text{RMSE}_h = \sqrt{\frac{\sum_{n=1}^{N_h}(g_n - \hat{g}_n)^2}{N_h}},$$

where N_h is the number of h-steps ahead forecasts computed, g_n is the actual value of the respective variable and $\hat{g}_n$ is the corresponding forecast.

ii) the hit rate states for a given horizon the percentage of cases in which the forecast movement direction of a variable relative to its today's level coincides with the direction of change of the realised data. Hence, formally the hit rate for a horizon h (HR_h) is defined as follows:

$\text{HR}_h = 1$ if $\{(g_{t+h} - g_t) > 0$ and $(\hat{g}_{t+h} - g_t) > 0\}$ or if $\{(g_{t+h} - g_t) < 0$ and $(\hat{g}_{t+h} - g_t) < 0\}$
and $\text{HR}_h = 0$ else. g_{t+h} denotes the actual value of the respective variable h steps ahead from time t while $\hat{g}_{t+h}$ is again the corresponding forecast.

iii) finally, the growth rates' sign matching indicates for each horizon the percentage of cases in which the sign of the y-o-y growth rate of the forecast series matches the sign of the y-o-y growth rate of the true series.

Table A1: Results of the Model Evaluation
Bulgaria

Steps ahead	**Obs.**	**Diebold-Mariano**		**Hit rate**		**Growth rates' sign matching**	
		GDP	**IMP**	**GDP**	**IMP**	**GDP**	**IMP**
1	38	**0.0005** (2.6934)	0.0001 (0.3806)	0.4736	0.6842	1.0000	1.0000
2	38	**0.0010** (3.5198)	0.0005 (0.6791)	0.500	0.7895	1.0000	0.9736
3	38	**0.0029** (3.2060)	**0.0018** (1.9564)	0.3947	0.8157	1.0000	0.9473
4	37	**0.0049** (3.5471)	**0.0072** (2.3823)	0.4594	0.6486	0.9736	0.9473
5	36	**0.0084** (3.6067)	**0.0120** (2.3771)	0.4167	0.6388	0.9473	0.9473
6	35	**0.0116** (3.6860)	**0.0209** (2.7308)	0.4571	0.62857	0.9210	0.9210
7	34	**0.0154** (3.6634)	**0.0282** (2.7989)	0.4412	0.6471	0.8947	0.8947
8	33	**0.0191** (3.7205)	**0.0349** (2.8058)	0.5151	0.6667	0.8684	0.8684

Czech Republic

Steps ahead	**Obs.**	**Diebold-Mariano test**			**Hit rate**			**Growth rates' sign matching**		
		GDP	IMP	ER	GDP	IMP	ER	GDP	IMP	ER
1	47	0.0001 (1.6647)	0.0001 (0.9595)	0.0000 (-0.4352)	0.6596	0.8298	0.6383	0.9149	0.9787	0.9574
2	47	0.0002 (1.7022)	-0.0004 (-0.9694)	-0.0002 (-0.5048)	0.7660	0.8936	0.7447	0.8511	0.9574	0.8936
3	47	0.0005 (1.4535)	-0.0020 (-1.6231)	-0.0007 (-0.9680)	0.8298	0.9787	0.5957	0.8723	0.9574	0.8936
4	46	0.0010 (1.7104)	-0.0021 (-1.5781)	-0.0006 (-0.8380)	0.8478	0.9565	0.6522	0.8511	0.9574	0.7447
5	45	0.0016 (1.7808)	**-0.0022** (-1.8664)	-0.0004 (-0.5078)	0.9111	0.9333	0.7111	0.8511	0.8723	0.7872
6	44	0.0024 (1.9416)	-0.0025 (-1.6258)	-0.0007 (-0.6151)	0.9091	0.9318	0.8182	0.8511	0.8511	0.8723
7	43	0.0032 (1.9628)	-0.0028 (-1.2980)	-0.0012 (-0.7546)	0.9070	0.9767	0.8140	0.8298	0.8298	0.8723
8	42	0.0040 (1.8803)	-0.0033 (-1.2586)	-0.0022 (-1.0418)	0.9286	0.9762	0.8571	0.8298	0.8085	0.8936

Croatia

Steps ahead	Obs.	Diebold-Mariano test			Hit rate			Growth rates' sign matching		
		GDP	IMP	ER	GDP	IMP	ER	GDP	IMP	ER
1	47	**0.0003** (2.6356)	0.0002 (0.7954)	0.0000 (0.9892)	0.6596	0.5957	0.5745	1.0000	1.0000	0.8298
2	47	0.0008 (1.5228)	0.0005 (0.6422)	0.0001 (1.6392)	0.6170	0.6170	0.4468	0.9787	0.9574	0.7660
3	47	0.0017 (1.3882)	0.0002 (0.1509)	**0.0003** (1.9741)	0.6383	0.5957	0.4255	0.9574	0.8936	0.7660
4	46	**0.0033** (1.8100)	0.0013 (0.5469)	0.0003 (1.2612)	0.5652	0.5435	0.4783	0.9149	0.8723	0.7021
5	45	**0.0044** (1.6504)	0.0011 (0.3334)	0.0000 (-0.0304)	0.6444	0.6000	0.6000	0.8936	0.8723	0.7234
6	44	0.0056 (1.4461)	0.0013 (0.3023)	-0.0003 (-0.9725)	0.6591	0.6364	0.5227	0.8723	0.8511	0.6809
7	43	0.0069 (1.3670)	0.0015 (0.2794)	-0.0006 (-1.3621)	0.6512	0.6512	0.5814	0.8298	0.8298	0.5319
8	42	0.0092 (1.4501)	0.0022 (0.3517)	-0.0008 (-1.6004)	0.6667	0.6905	0.5476	0.8085	0.8298	0.4681

Hungary

Steps ahead	Obs.	Diebold-Mariano test			Hit rate			Growth rates' sign matching		
		GDP	IMP	ER	GDP	IMP	ER	GDP	IMP	ER
1	47	0.0000 (0.4965)	-0.0001 (-0.3773)	-0.0001 (-1.3411)	0.7021	0.7660	0.6383	1.0000	1.0000	0.9362
2	47	0.0000 (0.0403)	0.0001 (0.1567)	-0.0003 (-0.7717)	0.7872	0.8298	0.5957	1.0000	0.9787	0.8723
3	47	-0.0005 (-1.4172)	-0.0002 (-0.0931)	-0.0002 (-0.2829)	0.9574	0.9149	0.6383	1.0000	0.9574	0.8511
4	46	**-0.0008** (-1.7106)	0.0003 (0.0989)	0.0000 (0.0051)	1.0000	0.9565	0.6087	0.9787	0.9362	0.8936
5	45	**-0.0011** (-1.9570)	0.0004 (0.1437)	-0.0001 (-0.0483)	0.9778	0.9556	0.5111	0.9574	0.9149	0.8723
6	44	**-0.0014** (-1.9966)	0.0002 (0.0485)	-0.0004 (-0.1386)	0.9773	0.9545	0.4773	0.9362	0.8936	0.8085
7	43	**-0.0018** (-1.9919)	-0.0002 (-0.0360)	-0.0006 (-0.1781)	0.9767	0.9535	0.4651	0.9149	0.8511	0.7447
8	42	**-0.0024** (-1.9448)	0.0002 (0.0421)	-0.0017 (-0.4158)	0.9762	0.9762	0.4286	0.8936	0.8298	0.7234

Poland

Steps ahead	Obs.	Diebold-Mariano test			Hit rate			Growth rates' sign matching		
		GDP	IMP	ER	GDP	IMP	ER	GDP	IMP	ER
1	47	**0.0002** (1.7399)	-0.0006 (-1.1249)	-0.0004 (-1.5348)	0.7447	0.6383	0.6383	1.0000	0.8936	0.8511
2	47	**0.0005** (2.6867)	-0.0004 (-0.4908)	-0.0007 (-1.3767)	0.7660	0.7447	0.5319	1.0000	0.9149	0.8085
3	47	**0.0008** (2.7561)	-0.0002 (-0.1140)	**-0.0019** (-1.8728)	0.7660	0.7021	0.6383	0.9787	0.8936	0.7447
4	46	**0.0010** (2.8986)	0.0009 (0.3555)	**-0.0030** (-2.0718)	0.8261	0.8043	0.5870	0.9574	0.8085	0.6170
5	45	**0.0010** (2.9687)	0.0019 (0.5925)	**-0.0052** (-2.6300)	0.8889	0.8444	0.5333	0.9362	0.7872	0.5745
6	44	**0.0009** (2.2149)	0.0024 (0.6268)	**-0.0077** (-3.0989)	0.9545	0.8636	0.5909	0.9149	0.7660	0.5532
7	43	0.0006 (1.1152)	0.0011 (0.2316)	**-0.0103** (-3.4557)	0.9767	0.9070	0.6047	0.8936	0.7660	0.5319
8	42	0.0005 (0.7063)	0.0005 (0.0975)	**-0.0135** (-3.8108)	1.0000	0.8810	0.5952	0.8723	0.7447	0.4468

Note: *t*-values are reported in parentheses below the Diebold-Mariano test statistic, values in bold imply rejection of the null hypothesis of no difference between the ECM and the AR(1)-benchmark at the 10% significance level or more. If the test statistic is negative (positive), the ECM (the AR) performs better in terms of predictive accuracy. The hit rate reports the percentage of cases in which the forecast movement direction of a variable relative to its today's level coincides with the direction of change of the realised data. The growth rates' sign matching indicates for each horizon the percentage of cases in which the sign of the y-o-y growth rate of the forecast series matches the sign of the y-o-y growth rate of the true series.