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The accuracy assessment of macroeconomic forecasts based on econometric models for Romania

Mihaela Simionescu[a]*

[a]*Institute for Economic Forecasting of the Romanian Academy, Bucharest, 050711, Romania*

Abstract

The forecasts accuracy evaluation became a constant preoccupation of specialists in forecasting, because of the failure of predictions that caused the actual economic crisis. The objective of this research is to model and predict some economic variables corresponding too few macroeconomic blocks for Romanian economy. The forecast method is represented by econometric models. Moreover, the accuracy of these predictions is assessed, VARMA models generating more accurate short-run forecasts for inflation, real GDP and interest rate in Romania (horizon: 2012-2013) compared to VAR and AR models. The econometric models proposed for unemployment rate, exchange rate and rate of monetary supply determined better forecasts than random walk.

Keywords: econometric model; VARMA model; forecast; accuracy; naïve forecasts;

1. Introduction

The actual economic crisis that was explained only by arguments related to forecasts uncertainty determined a more interest in assessing predictions accuracy. Actually, this evaluation is a mirror of the forecasting process quality. The econometric model is one of the most utilized forecasting methods. There is an important relationship

* Corresponding author. Tel.: 004 021-760-4241; fax: 004 021-760-4241.
E-mail address: mihaela_mb1@yahoo.com

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between the econometric model and the prediction based on it. Actually, the accuracy assessment helps us in improving the econometric model, but also the forecasting process itself. For example, an overestimated forecast is a clear key that our econometric model did not considered the shocks in the economy.

The original contribution of this research is related to the proposal of some econometric models for describing the evolution of some macroeconomic indicators in Romania, but also for making predictions. On the other hand, the assessment of forecasts accuracy was made, some of the models proving to generate better predictions than the naïve ones.

2. Literature

The high forecasts accuracy is an important objective for many specialists in forecasting. Our objective is to evaluate the accuracy in order to apply a suitable strategy for growing the degree of predictions performance. In economic crisis the accuracy decreases, the necessity of assessing the accuracy growing. The forecasts accuracy is a very large domain of research, an exhaustive presentation of it being impossible. But, some of the recent results will be described.

Bratu (2013) proved that the filters, but also Holt Winters procedure could be used as strategies to get more accurate predictions for inflation rate in USA, when the initial expectation are provided by SPF. The Holt-Winters method gave better results. According to Bratu (Simionescu) (2012), the combined forecasts are a suitable way of improving the unemployment forecasts in Romania.

The authors Bianchi and Deschamps (2012) concluded that there are large differences between macroeconomic forecasts for China regarding the accuracy measures for consumption and investment, GDP and inflation.

Allan (2012), who used quantitative and qualitative techniques to assess the forecasts accuracy, proved that combined forecasts are a suitable way to improve the OECD predictions for GDP in G7 countries.

Abreu (2011) evaluated the performance of macroeconomic forecasts made by European Commission, International Monetary Fund and Organization for Economic Cooperation and Development and two private institutions, which are The Economist and the Consensus Economics. The author analyzed the directional accuracy and the ability of predicting an eventual economic crisis.

In Netherlands, experts made predictions starting from the macroeconomic model used by the the institution specialized in policy analysis known as CPB. For the period 1997-2008 was reconstructed the model of the experts macroeconomic variables evolution and it was compared with the base model. The conclusions of Franses et al. (2011) were that the CPB model forecasts are in general biased and with a higher degree of accuracy.

Reeve and Vigfusson (2011) compared the performance of forecasts based on futures, choosing as a reference model the autoregressive model of order one and the autoregressive model of order one with constant.

Kurita (2010) showed that his predictions based on an autoregressive fractionally integrated moving average model of the unemployment rate outperformed the naïve predictions in what concerns the performance.

In their study, Shittu and Yaya (2009) evaluated the performance of exchange rate forecasts in England and USA, their predictions being based on ARIMA and ARFIMA models. The authors recommended the use in predictions of the ARFIMA models in both countries.

Edge et al. (2009) evaluated the performance of forecasts made by Federal Reserve staff and of those based by a time-series model and a DSGE model. Gorr (2009) recommended the use of classical accuracy measures when a normal evolution of the economy is expected, while the ROC curve is more suitable for crisis times.

Lam et al. (2008) made a comparison of exchange rate forecasts' degree of performance, showing that combined forecasts are better than the predictions that used only one model.

The authors Heilemann and Stekler (2007) gave the following arguments for the lack of high accuracy for G7 macroeconomic predictions: unsuitable forecasting methods and unsuitable expectations regarding the degree of performance.

In the research of Meese and Rogoff (1983), the authors proved that random walk process generates better forecasts than structural models.

3. Modelling and predicting macroeconomic indicators in Romania

Some econometric models corresponding to macro-economic blocks are described, the data referring to Romanian economy. These econometric models are used as forecast methods.

3.1. Econometric models for macroeconomic variables: interest rate, real GDP, inflation rate

A VARMA ***(vector autoregressive moving average)*** model is estimated using the full information maximum likelihood (FIML) described by Durbin (1963). This method provides estimates for parameters and standard errors of the parameters, including the constants. The model was expressed in state-space form for which the methods based on Kalman filter are used for optimisation. The method, also used by Metaxoglou ș i Smith (2007), was applied in Matlab and the following model was obtained:

$$y_t = \begin{pmatrix} 0.94836 & 0.28352 & 0.82741 \\ 0.97439 & 0.99003 & 3.24226 \\ 0.95583 & 0.92943 & 0.67843 \end{pmatrix} \cdot y_{t-1} + \varepsilon_t + \begin{pmatrix} -0.96483 & 0.77835 & 0.46774 \\ 0.98392 & 0.79350 & 0.87795 \\ 0.15205 & 0.14592 & 0.08337 \end{pmatrix} \cdot \varepsilon_{t-1}, \quad where$$

$$y_t = \begin{pmatrix} GDP\_r_t \\ \Delta \inf lation\_r_t \\ \Delta \operatorname{int} erest\_r_t \end{pmatrix} \qquad (1)$$

Table 1. The estimation of ARMA and VAR models

Variables	ARMA models
Inflation	$\Delta inflation\_r_t = -0.958 + 0.695 \cdot \Delta inflation\_r_{t-1}$
Interest rate	$\Delta interest\_r_t = -0.062 + 0.432 \cdot \Delta interest\_r_{t-1} - 0.2863 \cdot \varepsilon_{t-1}$
Growth in Real GDP	$\Delta GDP\_r_t = 3.608 + 0.501 \cdot \Delta GDP\_r_{t-1}$
Variables	**VAR model**
Inflation Interest rate Growth in Real GDP	$\Delta inflation\_r_t = 0.2239 + 0.724 \cdot \Delta inflation\_r_{t-1} - 0.1169 \cdot \Delta interest\__{t-1} - 0.0861 \cdot \Delta GDP\_r_{t-1}$ $\Delta interest\_r_t = -0.2279 - 0.0115 \cdot \Delta inflation\_r_{t-1} + 0.1325 \cdot \Delta interest\_r_{t-1} + 0.0467 \cdot \Delta GDP\_r_{t-1}$ $\Delta r\_PIB_t = 0.2461 + 0.3193 \cdot \Delta ri_{t-1} - 0.0873 \cdot \Delta rd_{t-1} + 0.3657 \cdot \Delta r\_PIB_{t-1}$

3.2. Model for the growth in real GDP

The data related to real growth of GDP are provided by Eurostat for the period 1991-2012.

GDP_r_t- real GDP rate in year t compared to year t-1 (annual data)

We created in EViews a time variable of trend type (t): genr t=@trend(1990). This time variable takes the value 0 for the year 1990, then it grows successively in time with one unit in each year compared to the previous year. We estimated a linear trend using the model: $rPIB_t = a + bt + \varepsilon_t$.

Box-Jenkins procedure is used to model separately the residuals of the models where the trend was put in evidence. The residuals data series corresponding to "A" equation is not stationary, being necessary the first order differentiation. The differentiated data series is then modelled using Box and Jenkins methodology.

Table 2. Econometric models used to predict the rate of real GDP compared to the previous year (one-year-ahead variant)

Year in the forecast horizon	Econometric models
2011 (model A)	$GDP\_r_t = -0.1089 + 0.0257 \cdot t - 0.001017 \cdot t^2 + \varepsilon_t$. $\Delta\varepsilon_t = 0.00049 - 0.7753 \cdot \Delta\varepsilon_{t-2}$
2012 (model B)	$GDP\_r_t = -0.1033 + 0.0237 \cdot t - 0.0009 \cdot t^2 + \varepsilon_{*t}$. $\Delta\varepsilon_{*t} = 0.8948 \cdot \Delta\varepsilon_{*t-1} + 0.8642 \cdot \Delta\varepsilon_{*t-2}$
2013 (model C and D)	$GDP\_r_t = -0.0289 + 0.0041 \cdot t + \varepsilon_{**t}$. $\Delta\varepsilon_{**t} = -0.9217 \cdot \Delta\varepsilon_{**t-2}$ $GDP\_r_t = -0.08989 + 0.0193 \cdot t - 0.00066 \cdot t^2 + \varepsilon\ ***_t$. $\Delta\varepsilon\ ***_t = -0.908 \cdot \Delta\varepsilon_{***t-2}$

For differentiated series of the residuals AR(2) (auto-regressive of order 2) models were obtained. These models are used to predict the residuals that will be introduced in the initial equations and the real GDP rates will be computed in the end.

Table 3. Forecasts for the real GDP rate on the horizon 2011-2013

Year	One-year-ahead predictions	Forecasts on 3 years
2011	0.1842	0.1842
2012	0.1128	0.1662
2013	0.0663	0.1461
2013	0.0072	0.1842

The analysis of one-year-ahead predictions on the entire horizon put into evidence the decrease of real GDP rate. For 2013, the second model determined a lower rate compared to model C.

If the same model till the forecast origin is used for making predictions for 3 years (2011, 2012 and 2013), the anticipated real GDP rate has a lower decrease rhythm than the predictions made with one year ahead.

3.3. Model for unemployment rate

The unemployment rate (ur) is modelled using the dependencies with the index of real salary compared to 1990 ($Isal_{t-1/90}$), household saving rate (saving_r) and social pressure rate (r_pres), the exogenous variables being in the previous period and covering the period 1990-2012.

$$ur_t = f(Isal_{t-1/90}, saving\_rate_{t-1}, r\_pres_{t-1}) \quad (2)$$

The following model was estimated with bootstrapped coefficients:

$$ur_t = 16.7 - 7.15 \cdot Isal_{t-1_{(t-1)/90}} - 0.665 \cdot saving\_rate_{t-1_{t-1}} - 0.99 \cdot r\_pres_{t-1} \quad (3)$$

For the prediction corresponding to 2013, the following model was used:

$$ur_t = 16.66 - 6.84 \cdot Isal_{(t-1)/90} - 0.694 \cdot saving\_rate_{t-1_{t-1}} - 1.05 \cdot r\_pres_{t-1} \quad (4)$$

Table 4. Unemployment rate (%) predictions on the horizon 2011-2013

Year	Forecast
2011	4.8
2012	6.5
2013	5.6

The highest value of the unemployment rate is anticipated for 2012, being followed by a decrease in 2013, but with a value higher than in 2011 with 0.72 percentage points.

3.4. Model for money supply

The rate of real money supply M3 is predicted on the horizon 2011-2013 using annual data series (1994-2012) for variables like: real GDP growth (1994=100), interest real rate, index of consumer prices. The data are provided by World Bank. The coefficients are estimated using bootstrapping technique with 10 000 replications.

rM_t- rate of real money supply M3
$rPIB_t$- real GDP growth
ri_t- interest real rate
ICP_t- index of consumer prices compared to the value in 1994

Table 5. Econometric models used in forecasting with a year ahead the rate of real money supply

Year	Econometric model used in making the prediction for that year
2011	$rM_t = 60.0261 - 18.3019 \cdot (\log GDP\_r)_{t-1} + 0.6437 \cdot \Delta^2 ri_{t-1} + 68.6307 \cdot \Delta(\log(ICP_{t-1}))$
2012	$rM_t = 59.8337 - 18.1923 \cdot (\log GDP\_r)_{t-1} + 0.6457 \cdot \Delta^2 ri_{t-1} + 68.6298 \cdot \Delta(\log(ICP_{t-1}))$
2013	$rM_t = 45.9526 - 3.3051 \cdot (\log GDP\_r)_{t-1} + 0.1678 \cdot \Delta^2 ri_{t-1} + 23.3215 \cdot \Delta(\log(ICP_{t-1}))$

The econometric models put in evidence a negative correlation between rate of real money supply and the logarithm of GDP and a positive correlation of the indicator with logarithm of differenced index of prices, respectively double differenced interest rate. On short-run the money supply should be positively correlated with GDP. In this case, the economic agents anticipate the inflation before the increase in money supply.

Table 6. Forecasts for rate of real money supply (%) with a year ahead on the horizon 2011-2013

Year	One-year-ahead prediction	Registered value
2011	6.35	6.5
2012	6.77	7.5
2013	5.96	-

For 2012 an increase in the money supply was anticipated, but it was not enough large. For 2013, a decrease in the money supply is predicted.

4. The assessment of forecasts accuracy

We proposed a new comparison measure of accuracy for predictions based on VARMA model: GFESM (generalized forecast error of second moment) ratio relativ to VARMA model. This measure is invariant to operations with the same variables, but also with different variables.

$$GFESM = \left| E\left[\begin{pmatrix} e_{t+1} \\ e_{t+2} \\ \dots \\ e_{t+h} \end{pmatrix} \cdot \begin{pmatrix} e_{t+1} \\ e_{t+2} \\ \dots \\ e_{t+h} \end{pmatrix}^T \right] \right| \quad (5)$$

e_{t+h} - n-dimensional forecast error on the horizon h

We computed the ratios between GFESM (one quarter before) for each two models (h=1). For multivariate models GFESM is also separately computed.

Table 7. GFESM ratio relativ to VARMA model for one-step-ahead forecasts

Model	Real GDP rate	$\Delta ri\inf lation_t$	$\Delta r\int erest_t$	|GFESM|
VAR (AIC)	1,06*	1,12**	1,33*	1,41
ARMA	0,98	1,05	1,18*	-
Model naiv	0,93	1,55*	1,37*	-

* For a significance level of 5% the ratio is different from 1
** For a significance level of 10% the ratio is different from 1

The VARMA model proposed for Romania provided more accurate forecasts than VAR models for all variables. For inflation and interest rate these forecasts are better than the naive one.

Table 8. Ex-ante accuracy measures for forecasts in 2013 of GDP rate, unemployment rate and rate of money supply

Accuracy indicator	Rate of real GDP forecast based on:			Unemployment rate	Rate of monetary supply
	Model A	Model C	Model D		
Error	-0.066107202	0.0146	0.07513	0.880141497	1.54
Absolute error	0.066107202	0.0146	0.07513	0.880141497	1.54
Percentage error	-0.826340023	0.1825	0.939125	0.136189062	0.2053
U1 Theil's coefficient	0.292371058	0.100412655	0.885236244	0.073070213	0.1144

All the forecasts evaluation for 2013 is made under the assumption of keeping the same value registered in 2012. Only the GDP forecast based on model A is overestimated, indicating a value greater with 82.63% than the naive one. The D model generated the less accurate GDP rate forecast. The error of unemployment rate forecast will be around 13.61% of the predicted value in 2012. The anticipated accuracy for unemployment rare in 2013 is rather high, greater than the one registered in 2012. The forecast error of the rate of monetary supply will increase with 20.53% in 2013 compared to the effective value in 2012.

Table 9. Accuracy indicators for unemployment rate and rate of monetary supply forecasts (horizon: 2011-2012)

Accuracy indicator	Unemployment rate	Rate of monetary supply
ME	-0.262621102	0.44
MAE	0.600023434	0.44
RMSE	0.654979362	0.5269
U1	0.058887473	0.0388
U2	0.643637779	0.7151

For unemployment rate expectations was observed a constant overestimation for 2011-2012, the naive forecasts outperforming them. For the rate of monetary supply the predictions are better than the naive ones, U1 statistic having an extremly low value (0.04). The monetary supply underestimation is persistent, MAE and ME having the same value.

Conclusions

The forecasts accuracy assessment should follow any macroeconomic forecast. The econometric models proposed in this paper generated in most of the cases overestimated forecasts. This is an important key for the researcher. Our econometric models did not considered the shocks that appeared in the Romanian economy.

The forecasts based on VARMA model were superior in terms of accuracy to those based on VAR or AR(1) models. The naive forecasts provided for GDP rate more accurate appreciations. Only for unemployment rate and rate of money supply our econometric models were better than those based on random walk.

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