10. The Performance of Predictions Based on the Dobrescu Macromodel for the Romanian Economy

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Abstract

This research has two main objectives: the evaluation of forecast performance based on the Dobrescu macromodel for the Romanian economy on the horizon 1997-2012 and the proposal of some empirical strategies to improve the prediction accuracy. Seven macroeconomic indicators were selected and the most accurate forecasts are those for exchange rate, the less accurate being export rate predictions. Unlike the rest of the forecasts, these are biased. The best improvement in accuracy for the seven types of forecasts was obtained by applying Hodrick-Prescott filter and Holt-Winters adjustment. Most of the NCP forecasts are available from 2004. Therefore, a comparison of accuracy was made for 2004-2012 using Diebold-Mariano test. Dobrescu model provided more accurate forecasts on the horizon 2004-2012 compared to NCP for: GDP deflator, index of private consumption, index of consumer prices, export rate and exchange rate. NCP outperformed Dobrescu anticipations on the same horizon for GDP index and unemployment rate. During 2004-2012, Dobrescu model offered forecasts with a higher degree of efficiency compared to NCP for GDP deflator, consumer index of prices and exchange rate. Using a fixed-effects model based on three scenarios of the Dobrescu model for GDP deflator, index of private consumption, GDP index and index of consumer prices, the weak efficiency was checked only for GDP deflator and index of private consumption.

Keywords: forecasts accuracy, biasness, efficiency, performance, strategy, combined forecasts, Hodrick-Prescott filter

JEL Classification: C10, C14, L6

1. Introduction

The assessment of forecast performance has many advantages, implying the possibility of improving the accuracy, the decisional process, the result planning. The Dobrescu macromodel for the Romanian economy is used to build forecasts for the

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main macroeconomic variables since 1997. None of the studies until now treated separately *in extenso* the performance of prognoses based on the Dobrescu model.

Thus, the objective of our study is to assess the accuracy, the biasness and the efficiency of the predictions based on the Dobrescu model, indicating some empirical strategies to improve the future forecasts accuracy by analyzing the results of the historical forecasts. More empirical strategies of improving the forecasts accuracy were applied, but only some of them produced the desired results. For the forecasts provided for 1997-2012, the best strategy of improving forecasts is that based on the filtration of the predictions using the Hodrick-Prescott technique and the Holt-Winters model.

2. Literature

The forecast performance is an important key for checking the improvement in the forecasting process. In the context of the economic crisis this field of research grew in importance, one of the main causes of the recent crisis being the unrealistic expectations regarding the evolution of macroeconomic variables. This translates into a low performance of macroeconomic forecasts. In special literature there are three directions in evaluating the performance of macroeconomic forecasts: accuracy, bias and efficiency.

Meese and Rogoff's "Empirical exchange rate models of the seventies" remains the starting point for many researches on the comparing of accuracy and bias. In their 1983 study, the authors compared the RMSE and the bias of exchange rate forecasts, which were based on structural models and they drew the conclusion that was later used to improve macroeconomic forecasts performance. They demonstrated that random walk process generated better forecasts than structural models.

Deschamps and Bianchi (2012) concluded that there are large differences between macroeconomic forecasts for China regarding the accuracy measures for consumption and investment, GDP and inflation. The slow adjustment to structural shocks generated biased predictions, the information being utilized relatively inefficiently.

Allan (2012) obtained a proper accuracy for the OECD forecasts combined with outturn values of GDP growth for G7 countries between 1984 and 2010. The same author mentioned two groups of accuracy techniques used in assessing the predictions: quantitative forecasts accuracy statistics and qualitative accuracy methods.

Bratu (2012) proposed some empirical strategies to improve the accuracy of macroeconomic forecasts in USA. The method of historical accuracy proved to be the best way to get better forecasts in USA.

Abreu (2011) evaluated the performance of macroeconomic forecasts made by IMF, European Commission and OECD and two private institutions (Consensus Economics and The Economist). The author analized the directional accuracy and the ability of predicting a possible economic crisis.

Shittu and Yaya (2009) evaluated the performance of forecasts based on ARIMA and ARFIMA models for the exchange rate in the UK and the USA. The authors recommended the ARFIMA models as a better tool of predicting the exchange rate in both countries.

Dovern and Weisser (2011) used a broad set of individual forecasts to analyze four macroeconomic variables in G7 countries. During the analysis, large discrepancies between countries and also in the same country for different variables resulted regarding the accuracy, the bias and the forecasts efficiency. In general, the forecasts are biased and only a fraction of GDP forecasts are closer to the results recorded in reality.

In the Netherlands, experts make predictions starting from the macroeconomic model used by the Netherlands Bureau for Economic Policy Analysis (CPB). For the period 1997-2008 the model of experts in macroeconomic forecasting was reconstructed and it was compared with the base model. The conclusions of Franses, Kranendonkand Lanser (2011) were that the CPB model forecasts are in general biased and with a higher degree of accuracy.

Lam, Fung and Yu (2008) compared the prediction performance for the exchange rate when different forecasting methods are used: sticky price monetary model, uncovered interest rate parity model, Bayesian model and purchasing power parity model. The authors made also combined forecasts based on the mentioned models. The result was that combined predictions outperformed the ones based on a single model.

Heilemann and Stekler (2007) explain why macroeconomic forecast accuracy in the last 50 years in G7 has not improved. The first explanation refers to the critical approach to macro-econometric models and to forecasting models, and the second one is related to the unrealistic expectations of forecast accuracy. Problems related to the forecast bias, data quality, the forecast process, predicted indicators, the relationship between forecast accuracy and forecast horizon are analyzed.

In literature, there are several traditional ways of measurement, which can be ranked according to the dependence or independence of the measurement scale. A complete classification is made by Hyndman and Koehler (2005) in their reference study in the field, “Another Look at Measures of Forecast Accuracy “. The error is denoted by e_t, being the difference between the actual value and the predicted value. The prediction at time t is p_t and the actual value at time t is X_t.

Scale-dependent measures

The most used measures of scale dependent accuracy are:

Mean-Square Error (MSE) = average (e_t^2)

Root Mean Square Error (RMSE) = $\sqrt{MSE}$

Mean Absolute Error (MAE) = average ($|e_t|$)

Median Absolute Error (MdAE) = median ($|e_t|$)

RMSE and MSE are commonly used in statistical modeling, although they are affected by outliers more than other measures.

Scale-independent errors:

Measures based on percentage errors

The percentage error is given by: $pc_t = \frac{e_t}{X_t} \cdot 100$

The most common measures based on percentage errors are:

Mean Absolute Percentage Error (MAPE) = average ($|pc_t|$)

Median Absolute Percentage Error (MdAPE) = median ($|pc_t|$)

Measures based on relative errors

It is considered that $r_t = \frac{e_t}{e_t^*}$, where e_t^* is the forecast error for the reference model.

Mean Relative Absolute Error (MRAE) = average ($|r_t|$)

Median Relative Absolute Error (MdRAE) = median ($|r_t|$)

Relative measures

For example, the relative RMSE is calculated: $rel\_RMSE = \frac{RMSE}{RMSE_b}$, $where\ RMSE_b$ is the RMSE of "benchmark model".

The classical U1 Theil's coefficient is computed as:

$$U_1 = \frac{\sqrt{\sum_{t=1}^{n}(X_t - p_t)^2}}{\sqrt{\sum_{t=1}^{n} X_t^{\,2}} + \sqrt{\sum_{t=1}^{n} p_t^{\,2}}} \tag{1}$$

For making comparisons with the naïve forecasts based on random walk model, U2 Theil's statistic could be used:

$$U_2 = \frac{\sqrt{\sum_{t=1}^{n-1}\left(\frac{p_{t+1} - X_{t+1}}{X_t}\right)^2}}{\sqrt{\sum_{t=1}^{n-1}\left(\frac{X_{t+1} - X_t}{X_t}\right)^2}} \tag{2}$$

A value less than 1 for U2 implies a better prediction than the naive one.

Free-scale error metrics (which result from dividing each error by average error)

Hyndman and Koehler introduce in this class of errors "Mean Absolute Scaled Error " (MASE) in order to compare the accuracy of forecasts of more time series.

3. The Performance Assessment for Macroeconomic Forecasts Based on the Dobrescu Macromodel and Strategies to Improve the Prognosis Accuracy

A. The Evaluation of Forecast Performance

In this study, we used the forecasts provided by the Institute for Economic Forecasting using the Dobrescu (2010) model for macroeconomic variables on the horizon 1997-2012: inflation rate, unemployment rate, GDP deflator, GDP index, index of private consumption, exchange rate, exports rate. A smaller horizon was chosen for the NCP predictions because the data are not available from 1997 to 2003 for all the variables. However, the Dobrescu model predictions are provided since 1997. This model computes the short and medium-term economic implications regarding aspects like shifts in the external environment and internal policies.

Some accuracy measures were used to assess the first component of the forecasts performance: root mean squared error (RMSE), mean errors (ME), mean absolute errors (MAE), MASE (mean absolute scaled errors) and U1 Theil's statistic.

Table 1

Measures of Forecast Accuracy Based on Dobrescu Model and NCP Anticipations

Measures of forecast accuracy	Inflation rate*	Registered unemploy-ment rate*	GDP deflator *	Index of private consum-ption*	GDP index*	Export rate*	Exchange rate RON/EUR*	Unem-ploy-ment rate**	Unem-ploy-ment rate of NCP***
Horizon	1997-2012							2001-2012	2001-2012
RMSE	0.3967	0.1692	0.1626	0.2683	0.0157	0.4075	0.4560	1.7633	1.3052
ME	0.0907	0.0914	0.0626	0.0540	-0.006	0.3151	-0.2679	-0.563	-0.7273
MAE	0.2651	0.1206	0.1287	0.1110	0.0142	0.3322	0.3578	1.6364	1.0909
MASE	0.6667	2.9000	0.0654	0.4301	1.2000	0.1069	0.4754	1.0966	0.9977
U1	0.1731	0.1300	0.1327	**0.1296**	0.1532	0.4592	**0.1242**	0.1240	0.0920

*Source: Own computations using: * Forecasts based on the Dobrescu macromodel for more variables provided by the Institute for Economic Forecasting on the horizon 1997-2012, ** unemployment rate forecasts based on the Dobrescu model on the horizon 2001-2012 ***unemployment rate forecasts of NCP on the horizon 2001-2012.*

The accuracy of predictions based on the Dobrescu macromodel is rather high on the horizon 1997-2012, the best predictions being made for the exchange rate, which are followed by the index of private consumption. For the export rate, the lowest accuracy was obtained, even if these forecasts were better than the naive ones. A higher variability was registered for errors data series corresponding to exchange rate, export rate and inflation rate. Excepting the GDP index, all the other forecasts are underestimated on average. All the predictions are better than the naive ones, except for the estimates of unemployment rate and GDP index.

We used the forecasted values of the annual registered unemployment rate made for Romania by National Commission for Prognosis ***(NCP)*** and the Institute for Economic Forecasting ***(IEF)***. The forecasting horizon is 2001-2012. The objective is to assess the accuracy and to propose a strategy for improving the forecasts based on the Dobrescu macromodel of the ***IEF***.

According to all accuracy indicators for the forecasts made over the horizon 2001-2011, except for the mean error, the Institute for Economic Forecasting used the Dobrescu (2010) macromodel and provided the most accurate predictions for the unemployment rate. Only the forecasts of this institution outperformed the naïve predictions based on the random walk. The negative values of the mean error imply too high average predicted values for all institutions. The less accurate forecasts are made by the National Commission for Prognosis.

The Diebold-Mariano test is used to check the differences in forecast accuracy on the same horizon (2004-2012) for Dobrescu macromodel expectations and NCP prognoses. This test does not suppose restrictions like forecast errors with normal distribution, independent and contemporaneously uncorrelated prediction errors. The test statistics is based on the mean squared error.

Table 2

The Results of the Diebold-Mariano Test for Checking Differences in Accuracy between the Predictions Based on the Dobrescu Model and NCP Anticipations (Horizon: 2004-2012)

Variable	Statistic value	Decision - more accurate predictions provided by:
GDP deflator	S(1) = -3.815 p-value = 0.0001	Dobrescu model
Index of private consumption	S(1) = -1.74 p-value = 0.0819	Dobrescu model
GDP index	S(1) = .2322 p-value = 0.8164	NCP
Index of consumer prices	S(1) = -.3142 p-value = 0.7533	Dobrescu model
Unemployment rate	S(1) = 1.014 p-value = 0.3103	NCP
Exports rate	S(1) = -2.062 p-value = 0.0392	Dobrescu model
Exchange rate	S(1) = -3.038 p-value = 0.0024	Dobrescu model

Source: Author's computations.

According to the Diebold-Mariano test (results in Table 2), the Dobrescu model provided more accurate forecasts on the horizon 2004-2012 compared to NCP for: GDP deflator, index of private consumption, index of consumer prices, exports rate and exchange rate. NCP outperformed Dobrescu's anticipations on the same horizon for GDP index and unemployment rate.

The efficiency of forecasts is determined by a F test for the following regression model:

$$X_{t+1} = a + bX_{t+1,t} + \varepsilon_{t+1} \tag{3}$$

Where X_{t+1} the value of the indicator registered for year $(t+1)$; $X_{t+1,t}$ the forecast of the indicator made at moment t for the period $(t+1)$.

However, the horizon length is quite small in our case and this model will not be used for testing the efficiency.

Fair and Schiller (1989) proposed a test in order to compare the efficiency of two forecasts made by two different institutions for the same variable. To this end, they consider a simple linear regression model:

$$X_t - X_{t-1} = b_0 + b_1(X_1^p - X_{t-1}) + b_2(X_2^p - X_{t-1}) \tag{4}$$

Where X_t - the value recorded for variable X at time t; X_{t-1} - the value recorded at time $t-1$ for variable X; X_1^p the predicted value of the first institution; X_2^p - the predicted value of the second institution.

If $b1 > 0$ and $b2 = 0$, the second institution provides a forecast relatively inefficient, and the first institution forecast contains, in addition to the first one information, an essential piece of information about changes that may occur in the analyzed variable.

If $b2 > 0$ and $b1 = 0$, the first institution provides a relatively inefficient forecast.

If both parameters of the regression model are strictly positive, then each institution brings different information through the forecast.

The predictions based on the Dobrescu model are available from 1997, while those provided by the National Commission for Prognosis (NCP) are available from 2004 for all the mentioned variables in this study. Only for unemployment rate NCP provided forecasts from 2001.

We compared the efficiency of forecasts provided by the National Commission for Prognosis to that of predictions based on the Dobrescu macromodel on a common horizon (2004-2012). The horizon length is too small and the predictions might be correlated, generating the problem of multicolinearity in a multiple regression model. Therefore, a modified version of the test is proposed by the author by introducing a dummy variable for the provider. This dummy variable takes the value 0 for the first provider (Dobrescu model) and the value 1 for the second one (NCP).

$$X_t - X_{t-1} = b_0 + b_1(X_t^p - X_{t-1}) + b_2 provider + \varepsilon_t \tag{5}$$

If $b1 > 0$ and $b2 = 0$ => the first forecaster provided more efficient predictions.

If $b1 > 0$ and $b2 = 1$ => the second forecaster provided more efficient predictions

According to the results shown in Table 3, for predictions of unemployment rate, GDP index, private consumption index and exports rate there are not significant differences in efficiency between the two types of predictions over the interval 2004-2012. For the rest of the variables (index of consumer prices, GDP deflator and exchange rate) the Dobrescu model provided predictions with a higher degree of efficiency as compared to the NCP ones.

Table 3

The Comparison of Efficiency for the Predictions Provided by NCP and those Based on the Dobrescu Model on the Horizon 2004-2012

Forecasts	The "more" efficient forecasts provided by:
GDP deflator	Dobrescu macromodel
Private consumption index	No significant differences in efficiency
GDP index	No significant differences in efficiency
Consumer index of prices	Dobrescu macromodel
Unemployment rate	No significant differences in efficiency
Export rate	No significant differences in efficiency
Exchange rate RON/EUR	Dobrescu macromodel

Source: Own computations.

A test of weak efficiency regresses the error on a constant term and a lagged forecast error, according to Melander, Sismanidis and Grenoulleau (2007):

$$e_{t+1} = a + be_t + \varepsilon_{t+1} \tag{6}$$

The null hypothesis acceptance implies a weak efficiency (bias and/or serial correlation) for a Prob. associated to "b" higher than 0.05.

In order to solve the problem of small sets of data, a panel data approach will be more suitable for assessing the prediction efficiency and bias. The units are represented by the scenarios of a forecaster.

$$e_{t+1,i} = a + be_{t,i} + \varepsilon_{t+1,i} \tag{7}$$

Table 4

The Weak Efficiency of Some Predictions with Scenarios Based on the Dobrescu Model on the Horizon 2004-2012

Variable	b (Probability)	Decision
GDP deflator	-0.0037 (0.986)	Weak efficiency
Index of private consumption	0.1826 (0.349)	Weak efficiency
GDP index	0.6698 (0.002)	No weak efficiency
Index of consumer prices	0.516 (0.002)	No weak efficiency

Source: Own computations.

The weak efficiency hypothesis was checked only for predictions for GDP deflator and index of private consumption. For GDP index and index of prices forecasts the assumption of weak efficiency was rejected at a 5% level of significance on the horizon 2004-2012.

Corder (2003) showed that McNees (1987) and Fair and Schiller (1989) made early contributions in the field of bias and efficiency of the individual forecasts by consensus. Early results showed that the projections of the private sector are biased and uncorrelated with the rational expectation hypothesis. The presence of systematic bias was detected in the forecast of real GDP and inflation made by the private sector in the G7 countries during 1990-2005. The measuring and test of bias were based on regression models and nonparametric tests of accuracy of the ranks. Empirical research reached a conclusion already presented in the literature, namely, the discrepancy between rational expectation tests and the too pessimistic or too optimistic forecasts.

Bias in this context implies a zero mean forecast error series. In the literature rationality tests are used to check if the forecasts are optimal in relation to a certain criterion, if they are biased or ensure a good informational efficiency. The standard test of forecast bias – the Mincer-Zarnowitz test - starts from this model:

$$X_t = a + bp_t + e_t$$

X_t - actual values, p_t – predicted values

Holden and Peel proposed a modified version of the test, which is based on forecast errors by testing whether their mean (m) is zero: $X_t - p_t = m + e_t$.

Accuracy can be improved we know that there is autocorrelation between errors and other data available at the time the forecast is made. The correlation indicates an inefficient use of information from the past. X_i are the observed variables that influence the forecast, then:

$$e_Y(t-k,k) = \gamma + \sum_i \sum_{j>k} \delta_{i,j} X_i(t-j) + e_t \tag{8}$$

γ *and* $\delta_{i,j}$ are significantly different from zero, the forecasts can be improved if one takes into account the influence of X_i variables. However, tests of rationality are dependent on assumptions made for regression models. If the data series is non-stationary with unit roots, co-integration tests should be used. In the case of asymmetric loss functions the forecasts are rational, even if the error mean is zero.

For a single forecaster a test of rationality can be applied by running the following regression:

$$X_{t+k} = \beta_0 + \beta_{1t} p_{1,T+j} + \beta_2 p_{i,t+k} + \varepsilon^i_{t,k} \tag{9}$$

Where $X_{i,t}$ - the variable in the i's set of data of the forecaster at time *t* and X_{t+k} - actual values at time *(t+k)*

The efficiency assumption supposes that the variable known at time t or before this moment is orthogonal to $\varepsilon^i_{t,k}$. This implies that for any $X_{i,t}$ the parameter β_2 is 0. The unbiasedness supposes that in a regression model without $X_{i,t}$, the coefficients are restricted to: $\beta_0 = 0$ and $\beta_1 = 1$. For several variables like index of consumer prices, index of private consumption, GDP index and GDP deflator, several scenarios were provided by different versions of the Dobrescu model: base scenario, moderate scenario and desirable scenario.

So, to test for the assumption of unbiasedness we check if $\beta_0 = 0$ and $\beta_1 = 1$, while to test the efficiency hypothesis we check if $\beta_0 = 0$, $\beta_1 = 1$ and $\beta_2 = 0$.

The model will be applied to test for bias in the forecasts based on the three scenarios (base scenario, desirable scenario and moderate scenario). These scenarios are not available during 1997-2003. To check for bias the Wald test was applied to test the parameters' restrictions.

Table 5

The Assessment of Bias for Predictions in 3 Scenarios Based on the Dobrescu Model on the Horizon 2004-2012

Forecasts	β_0	β_1	**Value of Chi-square statistic**		**Decision**
			Chi-square	Probability	
GDP deflator	-0.029	1.148	8.708355	0.012853	Biased predictions
Index of private consumption	0.323	0.656	9.650944	0.008023	Biased predictions
GDP index	1.26	-0.095	42.90625	0.000000	Biased predictions
Index of consumer prices	0.372	0.468	54.94204	0.000000	Biased predictions

Source: Author's computations.

For a larger horizon (1997-2012) the biasedness can be checked using a simple t-test for the following regression $e_{t+1} = a + \varepsilon_{t+1}$ (10)

We have to test whether the parameter "a" differs or not significantly from zero.

Table 6

The Biasedness of the Forecasts based on the Dobrescu Macromodel in Romania (1997-2012)

Variable	**Biased/unbiased forecast (Probability associated to parameter "a")**
Private consumption	Unbiased (0.0568)
Exchange rate	Biased (0.0132)
GDP deflator	Unbiased (0.3774)
Exports rate	Biased (0.0003)
Inflation rate	Unbiased (0.4386)
GDP index	Unbiased (0.1267)
Unemployment rate	Unbiased (0.1201)

Source: Own computations.

Some of the forecasts (for private consumption, GDP deflator, inflation rate, GDP index and unemployment rate) are unbiased, while those of exchange rate and exports rate are biased on the horizon 1997-2012.

$$X_{T+j} = \alpha . p_{1,T+j} + (1-\alpha) p_{2,T+j} + e_{c,T+j}$$

There are three approaches in literature to the construction of combined forecasts:

1. The use of regression models

The ordinary least squares minimizes in relation to α the following sum: $\sum_{j=T+1}^{T+H} \hat{e}_{c,j}^2$.

$$e_{2,T+j} = \alpha(p_{1,T+j} - p_{2,T+j}) + C_{c,T+j}\,;\; e_{2,T+j} = X_{T+j} - p_{2,T+j} \tag{11}$$

The variance-covariance approach

$$e_{c,t} = \alpha \cdot e_{1,t} + (1-\alpha)\cdot e_{2,t}$$

$$Var(e_{c,t}) = \alpha^2 \cdot Var(e_{1,t}) + (1-\alpha)^2 \cdot Var(e_{2,t}) + 2\cdot\alpha\cdot(1-\alpha)\cdot C(e_{1,t}, e_{2,t}) \quad .$$

We determined:

$$\min Var(e_{c,t}) \Rightarrow \alpha^* = \frac{Var(e_{2,t}) - C(e_{1,t}, e_{2,t})}{Var(e_{1,t}) + Var(e_{2,t}) - 2\cdot Cov(e_{1,t}; e_{2,t})} \quad .$$

2. The serial correlation in errors equation

Diebold (1989) started with: $X_{T+j} = \alpha_0 + \alpha_1 p_{1,T+j} + \alpha_2 p_{2,T+j} + e_{c,T+j}$

The combined forecast is $p_{e,T+j} = \hat{\alpha}_0 + \hat{\alpha}_1\, p_{1,T+j} + \hat{\alpha}_2\, p_{2,T+j}$ (12)

Capistrain and Timmermann (2008) proved the superiority of combined forecasts compared to the individual ones, even if the rules of building combinations of forecasts were rather easy. The combination of models proposed by Bjørnland, Gerdrup, Jore, Smith and Thorsrud (2009) generated superior predictions compared to those made by the Norway Bank.

The combined forecasts are another possible strategy for more accurate predictions. The most utilized combination approaches are:

- optimal combination (OPT);
- equal-weights-scheme (EW);
- inverse MSE weighting scheme (INV).

Bates and Granger (1969) started from two forecasts $p_{1,t}$ and $p_{1,t}$ for the same variable X_t, derived h periods ago. If the forecasts are unbiased, the error is calculated as: $e_{i,t} = X_{i,t} - p_{i,t}$. The errors follow a normal distribution of parameters 0 and σ_i^2. If ρ is the correlation between the errors, then their covariance is $\sigma_{12} = \rho\sigma_1\sigma_2$. The linear combination of the two predictions is a weighted average: $c_t = m.p_{1t} + (1-m).p_{2t}$.The error of the combined forecast is: $e_{c,t} = m\cdot e_{1t} + (1-m)\cdot e_{2t}$.The mean of the combined forecast is zero and the variance is:

$$\sigma_c^2 = m^2 \cdot \sigma_1^2 + (1-m)^2 \cdot \sigma_{2t}^2 + 2 \cdot m \cdot (1-m) \cdot \sigma_{12}$$

By minimizing the error variance, the optimal value for m is determined (m_{opt}):

$$m_{opt} = \frac{\sigma_2^2 - \sigma_{12}}{\sigma_1^2 + \sigma_2^2 - 2 \cdot \sigma_{12}} \quad (13)$$

The individual forecasts are inversely weighted to their relative mean squared forecast error (MSE) resulting INV. In this case, the inverse weight (m_{inv}) is:

$$m_{inv} = \frac{\sigma_2^2}{\sigma_1^2 + \sigma_2^2} \quad (14)$$

Equally weighted combined predictions (EW) are obtained when the same weights are given to all models.

The Diebold-Mariano test (DM test) is utilized to check if the unemployment rate forecasts made by NCP and Dobrescu on the horizon 2001-2012 have the same accuracy. The unemployment rate forecasts made by NCP are available from 2001. The following steps are applied:

- The difference between the squared errors of forecasts (e^2) to be compared and the squared errors of reference forecasts (e^{*2}): $d_{t,t} = (e_{t,t}^2) - (e_{t,t}^{*2})$
- The following model is estimated: $d_{t,t} = a + \varepsilon_t$
- We test if "a" differs from zero, where the null hypothesis is that a=0 (equal forecasts). A p-value less than 0.05 implies the rejection of the null hypothesis for a probability of 95% in guaranteeing the results.

d1 is computed to make comparisons between IEF and NCP forecasts. The parameter is zero from statistical point of view, so there are not significant differences between the forecasts provided by the two institutions in terms of accuracy. If we take into account the results based on accuracy indicators and those of the DM test, we conclude that the best predictions are those made by the IEF.

Table 7

The Results of Ljung-Box Test (2001 2011)

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |****. |	. |****. |	1	0.484	0.484	3.3444	0.067
. |*** . |	. |* . |	2	0.374	0.183	5.5713	0.062
. | . |	. **| . |	3	0.042	-0.263	5.6024	0.133

Source: Own computations.

By applying qualitative tests for directional accuracy we check if there is a correct prediction of the change. A test of independence between the effective values and the direction of change can be applied in this situation, while the null hypothesis shows the independence.

A probability less than 0.05 implies the rejection of null hypothesis. All the asymptotic significances are greater than 0.05, which makes us to conclude that the directional changes in the outturn are independent of the predictions.

Table 8

The Results of the Test for Directional Accuracy

	Ur	Ec
Chi-Square	.818a	1.273b
Df	9	8
Asymp. Sig.	1.000	.996

Source: Own computations.

The U Theil's statistics were computed for the combined forecasts based on the three schemes; the results are shown in the following table.

Table 9

The Accuracy of Combined Forecasts for Unemployment Rate (2001-2011)

Accuracy indicator	NCP+IEF forecasts
U1 (optimal scheme)	0.1254
U2 (optimal scheme)	1.1063
U1 (inverse MSE scheme)	0.1105
U2 (inverse MSE scheme)	1.0116
U1 (equally weighted scheme)	0.0888
U2 (equally weighted scheme)	**0.9134**

Source: Own computations.

Only if the equally weighted scheme is utilized we got better forecasts for the combined predictions of NCP and IEF. All the combined predictions are better than the naïve ones excepting those of NCP and IEF using the OPT scheme.

We test the biasedness of the combined forecasts and all the combined forecasts were a very good strategy of getting unbiased forecasts.

Each combined forecast based on the INV scheme provided different information These efficient combined forecasts performed better than the original ones of the institutions in what concerns the efficiency.

Another technique of improving the forecast accuracy used by Bratu (Simionescu) (2013) is the application of filters to the predicted data. The author also recommends the use of exponential smoothing methods like the Holts Winters method.

The Hodrick-Prescott filter and the Holt-Winters exponential technique were applied to the original predictions and the accuracy of new forecasts was evaluated.

For predictions made for inflation rate all the proposed methods (Holt-Winters model and filters -HP, CF and BX) improved the accuracy of the initial forecasts based on the Dobrescu macromodel. For the rest of the variables, except for the export rate - unemployment, exchange rate, GDP index, GDP deflator and index of private consumption - only the Hodrick-Prescott filter and the Holt-Winters method improved the initial predictions. The great improvement is achieved by the Holt-Winters technique for inflation rate, unemployment rate, exchange rate and GDP index. The application of the HP filter is the best way to have a better forecast on the horizon 1997-2012 (Table 10).

Table 10

The Accuracy of Adjusted Forecasts Using U1 Theil's Coefficient (1997-2012)

Predictions based on:	**Inflation rate**	**Unemployment rate**	**Exchange rate**	**Exports rate**	**GDP index**	**GDP deflator**	**Private consumption index**
Dobrescu model	0.1731	0.13	0.242	0.4592	0.1532	0.1327	0.1296
HP filter	**0.0783**	**0.11**	**0.0706**	0.6572	**0.0742**	**0.1095**	**0.0386**
BK filter	**0.991**	0.918	0.9140	0.9466	0.6587	0.2376	0.9328
CF filter	**0.999**	0.973	0.9643	0.9537	0.7554	0.3768	0.988
Holt-Winters model	**0.049**	**0.086**	**0.0577**	0.6168	**0.0671**	**0.1153**	**0.0534**

Source: Own computations.

Another strategy implies the adjustment of prediction errors and the determination of new forecasts.

The strategy based on filtered errors did not prove to be efficient in our case, as none of the new predictions are more accurate, according to the values of U1 statistic (Table 11).

Table 11

The Accuracy of Forecasts Based on Filtered Errors Using U1 Theil's Coefficient (1997-2012)

Predictions based on:	**Inflation rate**	**Unemployment rate**	**Exchange rate**	**Exports rate**	**GDP index**	**GDP deflator**	**Private consumption index**
Dobrescu model	**0.1731**	**0.13**	**0.242**	**0.4592**	**0.1532**	**0.1327**	**0.1296**
HP filter	0.8908	0.3934	0.8585	0.8899	0.9735	0.2803	0.9697
Holt-Winters model	0.7509	0.3988	0.7586	0.9997	0.9071	0.3271	0.9478

Source: Own computations.

All in all, the combined predictions and the adjustment of forecasts using the econometric filter and the Holt-Winters technique proved to be suitable methods for improving the degree of accuracy of the initial expectations based on the Dobrescu model for the Romanian economy.

4. Conclusions

In this study we assessed the performance of forecasts based on the Dobrescu macromodel, following three directions: accuracy, biasedness, efficiency. The accuracy of predictions based on the Dobrescu macromodel is rather high on the horizon 1997-2012, the best predictions being made for the exchange rate, which are followed by the index of private consumption. Only the predictions for the exchange rate and the export rate are biased on the horizon 1997-2012.

For predictions of unemployment rate, GDP index, private consumption index and export rate there are not significant differences in efficiency between the two types of predictions over 2004-2012. For the rest of the variables (index of consumer prices, GDP deflator and exchange rate) the Dobrescu model provided predictions with a higher degree of efficiency compared to the NCP ones.

Combined forecasts proved to be a good strategy for improving the accuracy only in some cases. When the NCP prognoses for unemployment rate are combined with those based on the Dobrescu model for 2001-2012 in the INV scheme, the accuracy increases.

For predictions made for inflation rate all the proposed methods (Holt-Winters model and filters - HP, CF and BX) improved the accuracy of the initial forecasts based on the Dobrescu macromodel. For the rest of the variables, except for the export rate (unemployment, exchange rate, GDP index, GDP deflator and index of private consumption) only the Hodrick-Prescott filter and the Holt-Winters method improved the initial predictions made for 1997-2012.

The application of the Holt-Winters model and filters (HP, CF and BX) improved the accuracy of the inflation rate forecasts based on the Dobrescu macromodel for 1997-2012. For unemployment, exchange rate, GDP index, GDP deflator and index of private consumption forecasts only the Hodrick-Prescott filter and the Holt-Winters method improved the Dobrescu predictions. The great improvement is brought by the Holt-Winters technique for inflation rate, unemployment rate, exchange rate and the GDP index. The application of the HP filter is the best way to have a better forecast on the horizon 1997-2012.

References

Abreu, I., 2011. International organizations' vs. private analysts' forecasts: An evaluation. *Banco de Portugal*, 5(7), pp. 78-83.

Allan, G., 2012. Evaluating the usefulness of forecasts of relative growth. *Discussion Papers in Economics*, 12(14), pp. 347-352.

Bates, J. and Granger, C.W.J., 1969. The Combination of Forecasts. *Operations Research Quarterly*, 20(4), pp. 451-468.

Bratu, M., 2012. The reduction of uncertainty in making decisions by evaluating the macroeconomic forecasts performance in Romania. *Economic Research*, *25*(2), pp. 239-262.

Bjørnland, S. et al., 2012. Does Forecast Combination Improve Norges Bank Inflation Forecasts?. *Oxford Bulletin of Economics and Statistics*, 74(2), pp. 163-179.

Bratu (Simionescu), M., 2013. Filters or Holt Winters technique to improve the forecasts for USA inflation rate?. *Acta Universitatis Danubius. Œconomica,* 9(1), pp. 24-35.

Capistrain, C. and Timmermann, A., 2009. Forecast Combination With Entry and Exit of Experts. *Journal of Business&Economic Statistics,* 27(4), pp. 428-440.

CNP, 2013. Data base. [online] Available at: <http://www.cnp.ro/ro/prognoze> [Accessed on March 2013].

Corder, J.K., 2003. Managing Uncertainty.The Bias and Efficiency of Federal Macroeconomic Forecasts. *The 7th National Public Management Conference.* Washington DC: Georgetown University, pp. 34-52.

Deschamps, B. and Bianchi, P., 2012. An evaluation of Chinese macroeconomic forecasts. *Journal of Chinese Economics and Business Studies*, 10(3), pp. 229-246.

Diebold, F.X., 1989. Forecast combination and encompassing: Reconciling two divergent literatures. *International Journal of Forecasting*, 5(4), pp. 589-592.

Dobrescu, E., 2000. Medium-run Scenarios of the Romanian Economy. *Romanian Journal of Economic Forecasting*, 1(1), pp. 8-28.

Dobrescu, E., 2002. Updated Scenarios for the Romanian Economy–Medium-Term Dynamics. *Romanian Journal of Economic Forecasting*, 3(1), pp.5-16.

Dobrescu, E., 2012. Macromodel Simulations for the Romanian Economy. *Romanian Journal of Economic Forecasting*, 15(1), pp. 7-28.

Dobrescu, E., 2013. Updating the Romanian Economic Macromodel. *Romanian Journal of Economic Forecasting*, 16(4), pp. 5-31.

Dovern, J. and Weisser, J., 2011. Accuracy, unbiasedness and efficiency of professional macroeconomic forecasts: An empirical comparison for the G7. *International Journal of Forecasting*, 27 (2), pp. 452-465.

Fair R. and Shiller, R. J., 1989.The Informational Content of Ex-Ante Forecasts. *The Review of Economics and Statistics*, 71(2), pp. 325-331.

Franses, P.H. McAleer, M. and Legerstee, R., 2012. Evaluating Macroeconomic Forecasts: A Concise Review of Some Recent Developments, *Working papers of Department of Economics and Finance from University of Canterbury*, 2(1), pp. 120-134.

Heilemann, U. Stekler, H., 2007. Introduction to “The future of macroeconomic forecasting”. *International Journal of Forecasting*, 23(2), pp. 159-165.

Hodrick, R. and Prescott, E.C., 1997. Postwar U.S. Business Cycles: An Empirical Investigation. *Journal of Money, Credit, and Banking*, 29 (1), pp. 1–16.

Hyndman, R.J. and Koehler, A.B., 2005. Another Look at Measures of Forecast Accuracy. *Monash Working Paper,* 13(5), pp. 67-78.

Institute for Economic Forecasting and Centre for Macroeconomic Modelling, 2011. The "Dobrescu Macromodel" of the Romanian Market Economy - 2005 Version Yearly Forecast Preliminate for 2011, November Estimates. *Romanian Journal of Economic Forecasting*, 14(4), pp. 197-199.

Institute for Economic Forecasting and Centre for Macroeconomic Modelling, 2010. The "Dobrescu Macromodel" of the Romanian Market Economy - 2005 Version - Yearly Forecast – Preliminate for 2010, November estimate. *Romanian Journal of Economic Forecasting*, 13(4), pp. 208-212.

Institute for Economic Forecasting and Centre for Macroeconomic Modelling, 2009. The "Dobrescu Macromodel" of the Romanian Market Economy - 2005 Version Yearly Forecast - Preliminate for 2009. *Romanian Journal of Economic Forecasting*, 12(4), pp. 224-226.

Koop, G. and Korobilis, D., 2009.UK Macroeconomic Forecasting with Many Predictors: Which Models Forecast Best and When Do They Do So?. *Department of Economics University of University of Strathclyde Glasgow,* 9(3), pp. 34-65.

Lam, L. Fung, L. and Yu, I., 2008. Comparing forecast performance of exchange rate models. *Hong Kong Monetary Authority Working Paper,* 8(8), pp. 347-358.

McNees, S., 1987. Consensus Forecasts: Tyranny of the Majority. *New England Economic Review*, 11(2), pp. 15-21.

Melander A. Sismanidis G. and Grenoulleau, D., 2007. The track record of the Commission's forecasts - An update. *European Economy, Economic Papers*, 291(1), pp. 39-48.

Pauna, B. et al., 2008. The "Dobrescu Macromodel" Of The Romanian Market Economy - 2005 Version Yearly Forecast Autumn Forecast. *Romanian Journal for Economic Forecasting*, 9(4): 206-209.

Pauna, B. et al., 2008. The "Dobrescu Macromodel" of the Romanian Market Economy-2005 Version- Yearly Forecast Autumn Forecast. *Romanian Journal for Economic Forecasting*, 9(3): 129 – 131.

Pauna, B. et al., 2007. The "DOBRESCU" Macromodel of the Romanian Market Economy* - 2005 version - Yearly Forecast - actualised scenario. *Romanian Journal for Economic Forecasting*, 8(2), pp. 118-123.

Shittu, O.I. Yaya, O.S., 2009. Measuring forecast performance of ARMA & ARFIMA models: An application to US Dollar/UK pound foreign exchange rate. *European Journal of Scientific Research*, 32 (2), pp. 167-176.