A STRATEGY TO IMPROVE THE GDP INDEX FORCASTS IN ROMANIA USING MOVING AVERAGE MODELS OF HISTORICAL ERRORS OF THE DOBRESCU MACROMODEL

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Abstract. *In this paper article, two strategies based on the econometric approach are proposed in order to improve the forecast accuracy of GDP index in Romania. First, the index is predicted starting from an econometric model that reflects the relationship between the GDP index and the GDP deflator. Then, the errors of these forecasts are computed. On the other hand, the errors result directly from an econometric model that shows the relationship between the GDP index forecast errors and the GDP deflator prediction errors. The data series are historical errors of forecasts based on the Dobrescu macromodel. The forecasts errors of the GDP index based on the Dobrescu macromodel historical errors for 2009-2011 are lower than the errors taken directly from the proposed econometric model. However, the Dobrescu macromodel provided a better accuracy for the GDP index. If the historical errors are predicted using updated MA(1)models, the one-step-ahead forecasts are the most accurate, this being a suitable strategy to improve the prediction accuracy.*

Keywords: *accuracy, econometric models, forecasts, predictions, errors*

JEL Classification*: E21, E27,C51, C53*

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1. INTRODUCTION

An economic phenomenon can be described using two or more alternative econometric models. But from the multitude of models only one should be chosen, the one that generates the most accurate forecasts. On the other hand, after developing a certain prediction, some strategies could still be applied to improve its accuracy. The historical forecast errors of an indicator could be utilized to build another econometric model used in predicting the errors and consequently in forecasting the economic indicator.

In this paper article, knowing the economic relationship between the GDP index and the GDP deflator, new strategies of predicting the GDP index are proposed for Romania. In this country, the Dobrescu macromodel is used to forecast the GDP deflator and the GDP index. The relationship between the forecast errors might help us in predicting one of the indicators. The computation of the prediction errors can be made in two ways: directly from an econometric model or indirectly, when, first of all, the variable is forecasted. When these errors are known, other accuracy indicators could be computed in order to argue the choice of specific predictions known as the best.

The researchers imputed to the Dobrescu model its failure to predict the economic and financial crisis started in 2009. Therefore, we proposed to find out a suitable strategy to improve the accuracy of one macroeconomic indicator starting from the historical forecast errors of the Dobrescu macromodel.

The results of this research can be used in order to improve the forecasting process of the GDP index. Although the Dobrescu macromodel is quite criticated during the crisis started in 2009, it tends to perform rather good and it is recommended in predicting macroeconomic indicators.

2. MEASURING AND IMPROVING THE FORECAST ACCURACY

In this study we are interested in assessing the accuracy of forecasts based on econometric models which are a quantitative forecasting method. Recent studies target accuracy analysis using as a comparison criterion different models for making predictions or the analysis of forecasted values for the same macroeconomic indicators registered in several countries.

Franses, McAleer and Legerstee (2012) evaluated two forecasts based on three different methods: the two forecasts are based on different econometric models, one of the predictions is based on an econometric model and the other on a model and also intuition, both forecasts being the result of econometric models and intuition.

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 used relatively inefficient.

Allan (2012) obtained a good 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. In our study we are interested in the first category of techniques that is used to evaluate the accuracy of an institution or to compare the accuracy of different predictions.

Dovern and Weisser (2011) used a broad set of individual forecasts to analyze four macroeconomic variables in G7 countries. Analyzing accuracy, bias and forecasts efficiency, it results that there are large discrepancies between countries and also in the same country for different variables. In general, the forecasts are biased and only a fraction of GDP forecasts are closer to the results registered 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 the experts macroeconomic variables evolution was reconstructed and it was compared with the base model. The conclusions of Franses, Kranendonk and Lanser (2011) were that the CPB model forecasts were in general biased and with a higher degree of accuracy.

Gorr (2009) shows that the univariate method of prediction is suitable for normal conditions of forecasting while using conventional measures for accuracy, but multivariate models are recommended for predicting exceptional conditions when a ROC curve is used to measure accuracy.

Ruth (2008), using the empirical studies, obtained forecasts with a higher degree of accuracy for European macroeconomic variables by combining specific sub-group predictions in comparison with forecasts based on a single model for the whole Union.

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 criticism of macroeconomic models and forecasting models, and the second one is related to the unrealistic expectations of forecast accuracy. Problems related

to the forecast bias, data quality, the forecasting process, predicted indicators, the relationship between forecast accuracy and forecast horizon are analyzed.

Ledolter (2006) compares the mean square error of *ex post* and *ex ante* forecasts of regression models with a transfer function with the mean square error of univariate models that ignore the covariance and show superiority of predictions based on transfer functions.

Teräsvirta *et al*. (2005) examine the accuracy of forecasts based on linear autoregressive models, autoregressive with smooth transition (STAR) and neural networks (neural network-NN) time series for 47 months of the macroeconomic variables of G7 economies. For each model a dynamic specification is used and it shows that STAR models generate better forecasts than linear autoregressive ones. Neural networks in long horizon forecasts generated better predictions than the models using an approach from private to general.

Granger and Jeon (2003) consider four models for the U.S. inflation: a univariate model, a model based on an indicator used to measure inflation, a univariate model based on the two previous models and a bivariate model. Applying the mean square error criterion, the best prediction made is the on based on an autoregressive model of order 1 (AR (1)). Applying the distance-time method, the best model is the one based on an indicator used to measure the inflation.

Ericsson (1992) shows that the parameter stability and mean square error of prediction are two key measures in evaluating forecast accuracy, but they are not sufficient and it is necessary to introduce a new statistical test.

Bratu (2012) mentions states some important strategies to be used in practice in order to improve the forecast accuracy. One of these strategies is building combined forecasts in different variants: predictions based on linear combinations whose coefficients are determined using the previous forecasts and predictions based on a correlation matrix, the use of regression models for large data bases of predicted and effective values. On the other hand, we can apply the historical errors method, which implies that the same value of an accuracy indicator calculated for a previous period. Combined forecasts are another technique used to improve the forecast accuracy.

3. THE ACCURACY OF GDP INDEX PREDICTIONS BASED ON ECONOMETRIC MODELS

If we consider $\hat{X}_t(k)$ the predicted value after k periods from the origin time t, then the error at a future time (t+k) is: $e_t(t+k)$. 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 ".

In practice, the most used measures of forecast error are, according to Fildes and Steckler (2000):

- Root Mean Squared Error (RMSE)

$$RMSE = \sqrt{\frac{1}{n}\sum_{j=1}^{n} e_X^2 (T_0 + j, k)} \qquad (1)$$

- Mean error (ME)

$$ME = \frac{1}{n}\sum_{j=1}^{n} e_X (T_0 + j, k) \qquad (2)$$

The sign of the indicator value provides important information: if it has a positive value, then the current value of the variable was underestimated, which means expected average values are too small. A negative value of the indicator shows expected values too high on average.

- Mean absolute error (MAE)

$$MAE = \frac{1}{n}\sum_{j=1}^{n} \left| e_X (T_0 + j, k) \right| \qquad (3)$$

U Theil's statistics is calculated in two variants by the Australian Tresorery in order to evaluate the forecast accuracy.

The following denotations are used:

a- registered results

p- predicted results

t- reference time

e- error (e=a-p)

n- number of time periods

$$U_1 = \frac{\sqrt{\sum_{t=1}^{n} (a_t - p_t)^2}}{\sqrt{\sum_{t=1}^{n} a_t^2} + \sqrt{\sum_{t=1}^{n} p_t^2}} \quad (4)$$

If U_1 is closer to one, the forecast accuracy is higher.

$$U_2 = \sqrt{\frac{\sum_{t=1}^{n-1} \left(\frac{p_{t+1} - a_{t+1}}{a_t}\right)^2}{\sum_{t=1}^{n-1} \left(\frac{a_{t+1} - a_t}{a_t}\right)^2}} \quad (5)$$

If U_2 =1=> there are no differences in terms of accuracy between the two forecasts to compare.

If U_2 <1=> the forecast to compare has a higher degree of accuracy than the naive one.

If U_2 >1=> the forecast to compare has a lower degree of accuracy than the naive one.

The strategies proposed to predict the GDP index are original and dependent on the data series provided by the Romanian economy. These are used in order to improve the accuracy of forecasts using econometric models.

The GDP deflator is a price index in the Paasche system and it is calculated as a ratio of the nominal GDP to real GDP dynamics. The GDP index is calculated as a ratio the GDP in the current period to the GDP in the base period. The econometric model that expresses the relationship between the GDP index and the GDP deflator for 1998-2008 is:

$$I_{GDP_t} = 0{,}177 \cdot DEFL_{t-1} + 0{,}788 \cdot I_{GDP_{t-1}}^{2}. \quad (6)$$

I_GDP- GDP index

DEFL- GDP deflator

This econometric model is used to make predictions for 2009-2011.

The error was calculated as difference between the predicted and the registered values. In **Table 1** the errors based on this econometic model and on the Dobrescu macromodel are presented.

Table 1: *Ex post* **errors of GDP index forecasts based on econometric models**

Year	*Ex post* error based on the econometric model	Errors of forecasts based on the Dobrescu model
2009	-0,41	-0,208
2010	-0,422	-0,133
2011	-0,5	0,015

Source: Own computations using Excel and EViews.

The prediction of GDP index for 2012 is based on the following econometric model:

$$I_{GDP_t} = 0{,}187 \cdot DEFL_{t-1} + 0{,}768 \cdot I_{GDP_{t-1}}^{2}. \quad (7)$$

The expected error of the GDP index forecast for 2012 based on econometric model was 0.0459 percentage points.

The following econometric model is used to make predictions of the errors of the forecasts based on the Dobrescu macromodel from 2009 to 2011 is:

$$e_{I_{GDP_t}} = 0{,}187 \cdot e_{DEFL_{t-1}} + 0{,}768 \cdot e_{I_{GDP_{t-1}}}^{2}. \quad (8)$$

e_I_GDP - forecast errors of the GDP index for the Dobrescu model.

e_DEFL - forecasts errors of the GDP deflator for the Dobrescu model.

Starting from the errors calculated using the econometric model (8), the accuracy of forecasts was evaluated. In **Table 2** we can notice that the strategy based on the Dobrescu model provided lower errors.

Table 2: ***Ex post*** **errors of GDP index forecasts based on evaluating the accuracy of predictions using econometric model**

Year	*Ex post* forecast errors based on historical predictions errors of the Dobrescu model	Errors of forecasts based on the Dobrescu model
2009	-0,212	-0,208
2010	-0,208	-0,133
2011	-0,208	0,015

Source: Own computations using Excel and EViews.

Analyzing the sign of errors, an underestimation of errors forecasts based on econometric model can be noticed. The effective errors are underestimated only for 2009 and 2010.

The errors of forecasts based on the econometric model for 2009-2011 are lower than the errors taked directly from the econometric model. However, the Dobrescu macromodel provided a better accuracy for the GDP index.

The first strategy of calculating the errors will be denoted by A and the second one by B. Some accuracy indicators are computed in **Table 3** for forecasts based on these strategies and for Dobrescu model predictions on the forecasting horizon 2009-2011.

Table 3: Accuracy indicators for GDP index predictions

Accuracy indicators (percentage points)	Strategy A	Strategy B	Dobrescu model predictions
Mean error (ME)	-0,444	-0,21	-0,108
Mean absolute error (MAE)	0,444	0,21	0,118
Root mean squared error (RMSE)	0,198	0,044	0,02
U1	0,357	0,132	0,071
U2	3,217	2,224	12,437

Source: Own computations using Excel.

The underestimation of the forecasts based on the A and B strategies is very persistent because of the negative values of the ME and of the same absolute values of the MAE. The U1 statistics values show that the predictions based on the Dobrescu model are the most accurate, but, according to U2 values, there isn't any forecast better than the naive one.

Some moving average of order one (MA(1)) models were taken for the error data series in first difference of the GDP index starting from Dobrescu model. These models are presented in **Tabel 4**. Only the data series in first difference is stationary ($\Delta e_{I_{GDP_t}}$ – *the errors of GDP index in first difference*). The models are updated in order to make one-step-ahead predictions.

Table 4: MA(1) models for the historical errors in first difference

Period of reference for data series	MA models
1997-2008	$\Delta e_{I_{GDP_t}} = -0.108 + 0.667 * \varepsilon_{t-1} + \varepsilon_t$
1997-2009	$\Delta e_{I_{GDP_t}} = -0.111 + 0.697 * \varepsilon_{t-1} + \varepsilon_t$
1997-2010	$\Delta e_{I_{GDP_t}} = -0.121 + 0.636 * \varepsilon_{t-1} + \varepsilon_t$

Source: Own computations using Excel and EViews.

In **Table 5**, the predicted errors based on historical errors of Dobrescu model forecasts are lower than the simple errors of macromodel predictions. Indeed, this strategy improves the prediction accuracy, the tendency of underestimation being the same.

Table 5: ***Ex post*** **errors of GDP index forecasts based on evaluating the accuracy of predictions using a econometric model**

Year	Forecast errors based on MA(1) models of the historical errors of Dobrescu model predictions	Errors of forecasts based on the Dobrescu model
2009	-0,04937	-0,208
2010	-0,12076	-0,133
2011	-0,007266	0,015

Source: Own computations using Excel and EViews.

4. CONCLUSIONS

The necessity of assessing the macroeconomic forecasts tends to be bigger in crisis periods and a suitable strategy to improve the accuracy crowns the efforts of the researchers.

For the years of the present crisis period in Romania (2009-2011) the literature noted the failure of econometric models from Dobrescu macromodel to anticipate the crisis. Therefore, we proposed another econometric model to predict one of the indicator, the GDP index, starting from the relationship between this variable and the GDP deflator. The historical errors of the forecasts based on the Dobrescu model are used to build another econometric model. These are two alternatives of getting other predictions for the same variable. The central problem is to check if the new forecasts are more accurate than those based only on Dobrescu estimations.

The predictions based on the Dobrescu macromodel have a better degree of accuracy than those based on proposed strategies. However, the forecast errors based on an econometric model are lower than the errors taken directly from the econometric model used to make predictions for 2009-2011. The other accuracy indicators reflect the superiority of forecasts resulting directly from Dobrescu model. The explication might be that in the Dobrescu model more dependencies between the variables are included.

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