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ECONOMETRIC FORECASTING OF IMPORTS AND EXPORTS INDEXES IN ROMANIA

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Abstract: *The objective of this research is the assessment of accuracy for imports and exports predictions based on econometric models. For the Romanian economy, the indexes of exports and imports are forecasted on the horizon 2011-2013. For the first period (2011-2012), all the forecasts are overestimated, this being an important clue that these predictions based on econometric models did not take into account the shocks in the economy. The imports' indexes anticipations are more accurate than those made for the exports' indexes. Moreover, the ex-ante evaluation of the predictions was made for 2013, under the assumption that this year the indicators would have the value from 2012. An underestimation of the exports is expected for 2013.*

Key words: *forecasts, accuracy, econometric models, exports, imports.*

1. Introduction

There are many quantitative methods used in forecasting imports and exports, the econometric models being the most used tool. The relationships between macroeconomic variables permanently affected by changes, mostly in unstable periods like crisis times, are better put into evidence using econometric modelling. The description of the macroeconomic variables evolution is not enough, researchers being interested in making forecasts to anticipate the future evolution. It is important to know the future values for variables like imports and exports in order to ground the government policy. Moreover, imports and exports are components of GDP (gross domestic product), the predictions for GDP depending on the future values of exports and imports.

The forecasting process should be accompanied by the evaluation of these predictions in terms of accuracy. For the same variable, more alternative predictions could be offered, but using the accuracy criterion one should choose the best forecast that is less affected by errors.

Therefore, this article is organized on several sections that follow the logical demarche. After the estimation of the proposed models for imports and exports indexes, some alternative forecasts are made. The evaluation of these predictions is based on several accuracy measures: root mean square error, mean error, mean absolute error, and U1 and U2 coefficients proposed by Theil (1996).

2. Literature

Amano and Wirjanto (1994) considered imports a linear function of domestic demand and relative prices. The coefficients are estimated with co-integration techniques and generalized

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method of moments. KOSMOS, the macroeconomic model for Sweden, includes equations for exports of manufactured goods and for services as Johansson (1998) showed. The demand depends on the Swedish export price and a measure of foreign income. The models are used in predicting exports.

Senhadji and Montenegro (1999) modelled the exports of many countries using a fully modified estimator. Mehta and Mathur (2003) explained the exports as a function of trade partners' demand. Bussiere, Fidrmuc and Schnatz (2005) used an augmented gravity model. The panel data estimation put into evidence a positive dependence between trade and GDP. Anderton, Baltagi, Skudelni and Sousa (2005) used the three-stage least squares to determine the import demand.

Emel'yanov (2007) used non-linear regression models to describe the dynamics of Russian imports and exports during 1990-2005. The models used annual and monthly data, being used to forecast the evolution of exports and imports in Russia.

Chen and Dong (2012) used a panel data analysis to study the relationship between exports, imports, capital stock, GDP and labour capital in China. The method applied in this case is a non-parametric local linear kernel estimation.

Pistoresi and Rinaldi (2012) used co-integration procedure and causality tests to analyze the relationship between real exports, imports and GDP in Italy in the period 1993-2004. After the Second World War, exports were no longer the main cause of economic growth.

According to economic theory, imports and exports are correlated with GDP, but, using a panel data analysis, Prada (2013) showed that GDP is strongly correlated with other variables regarding migration.

Uncertainty is a factor that strongly affects predictions, being the main cause of the present economic crisis. According to Mahika and Ditu-Furtuna (2012), uncertainty increased very much in the present economic crisis. The external shocks that affect a national economy were assessed by Mirdala (2012) for the Czech Republic and the Slovak Republic, the influence of these shocks affecting the forecasting process, too. The assessment of forecasts accuracy is important in order to reduce the future degree of uncertainty that affects the predictions, but Alecu (2011) proposed some political methods to absorb the uncertainty. However, for variables like imports and exports, there are also microeconomic aspects that influence the predictions. According to Munthiu (2010), consumer behaviour influences the buying decision going from this microeconomic level to the macroeconomic one. As Potincu and Muresan (2009) stated, promotion techniques are an important instrument of marketing policy that influence the consumer's decision to buy or not to buy a product. These microeconomic aspects are reflected at macroeconomic level being quantified by these indicators of imports and exports. In Romania, imports are very large, because of many foreign commercials.

By assessing the forecasts accuracy, we have a mirror of the forecasting process efficiency. If alternative predictions are made for the same variable, the interest is to choose the most accurate one.

3.1. Forecasts for import and export indexes

The data series, provided by Eurostat, refer to the index of real imports, the index of the USD/RON exchange rate in the previous period and the index of exports change in the previous period, covering the period 1995-2012. The reference base is given by the corresponding values in 1995. The predictions are made for 2011-2012 and then for 2013.

$Iimp_t$- fixed base imports index in period "t" (annual data)

Ier_{t-1}- index for average USD/RON exchange rate in period "t-1" (annual data)

$Iexp_{t-1}$- index of change for the real exports in the previous period "t-1" (annual data)

The model form is:

$Iimp_t = c_0 \cdot Ier_{t-1}^{c1} \cdot Iexp_{t-1}^{c2} \cdot \varepsilon_t$

The model is transformed as it follows (the logarithm is applied):

$\ln\_Iimp_t = lnc_0 + c_1 \cdot lnIer_{t-1} + c_2 \cdot lnIexp_{t-1} + ln\varepsilon_t$

This model is not valid, another one being proposed for 1995-2012, a model used to make prediction in 2013.

$$\ln\_Iimp_t = 0.243 + 1.545 \cdot lnIer_{t-1} - 1.623 \cdot lnIexp_{t-1}^2$$

The following model is used for making predictions in 2011-2012:

$$\ln\_Iimp_t = 0.249 + 1.531 \cdot lnIer_{t-1} - 1.617 \cdot lnIexp_{t-1}^2$$

Econometric models for predicting mobile base imports index Table 1

Forecast horizon	Econometric models
2011-2012	$\ln\_Iimp_t = 0.239 + 1.463 \cdot lnIer_{t-1} - 1.422 \cdot lnIexp_{t-1}^2$ (I1) $\ln\_Iimp_t = 0.249 + 1.531 \cdot lnIer_{t-1} - 1.618 \cdot lnIexp_{t-1}^2$ (I2)
2013	$\ln\_Iimp_t = 0.234 + 1.469 \cdot lnIer_{t-1} - 1.421 \cdot lnIexp_{t-1}^2$ (I3) $\ln\_Iimp_t = 0.243 + 1.547 \cdot lnIer_{t-1} - 1.623 \cdot lnIexp_{t-1}^2$ (I4)

The assumptions necessary to be checked for linear regression models are not fulfilled, the coefficients being estimated by bootstrapping procedure with 10 000 replications. The errors have a normal distribution in this case. The homoscedasticity is tested using White test and the empirical significance value associated to LR statistic is less than 0,05. This implies that the hypothesis of homoscedasticity is not rejected. The homoscedasticity was also checked using another procedure, Goldfeld-Quandt, that also presented by Ciuiu (2010). According to the Durbin-Watson test applied for the errors' auto-correlation of order one, the statistic is placed between the upper limit (d_u) and 4-upper limit (4-d_u). This implies that the errors are non-correlated.

Forecasts for imports index on the horizon 2011-2013 Table 2

Year	Forecast based on I1 model	Forecast based on I2 model
2011	1.203817876	1.202508514
2012	1.202508514	1.20648867
	Forecast based on I3 model	Forecast based on I4 model
2013	1.193667586	1.196363623

The differences between the predictions based on alternative models are not significant, the tendency being a decreasing one.

Model for exports

The data series, provided by Eurostat, refer to the index of real exports, the index of real money supply in the previous period and the index of imports change in the previous period, covering the period 1995-2012. The reference base is given by the corresponding values in 1995. The predictions are made for 2011-2012 and then for 2013.

$Iexp_t$- exports index in comparable prices (1995=100) in period "t" (annual data)

Im_{t-1}- index of real money supply in the previous period (1995=100) (annual data)

$Iimp_{t-1}$- imports index in comparable prices (1995=100) in the previous period (annual data)

The form of the model is:

$Iexp_t = c_0 \cdot Im_{t-1}^{c1} \cdot Iimp_{t-1}^{c2} \cdot \varepsilon_t$

The logarithm is applied to make the parameters' estimation easier.

$\ln\_Iexp_t = lnc_0 + c_1 \cdot lnIm_{t-1} + c_2 \cdot lnIimp_{t-1} + ln\varepsilon_t$

The following valid model was obtained on the horizon 1995-2010:

$$\ln\_Iexp_t = 0.0578 + 0.9417 \cdot lnIimp_{t-1} - 0.0129 \cdot \frac{1}{lnIm_{t-1}}$$

Because of the low data series, the coefficients are estimated by bootstrapping with 10 000 replications and values of the variables are resampled:

$$\ln\_Iexp_t = 0.0484 + 0.954 \cdot lnIimp_{t-1} - 0.0125 \cdot \frac{1}{lnIm_{t-1}} \text{(E1)}$$

These models fulfil the assumptions of linear regression models estimated using ordinary least squares. The errors' distribution is normal and the White test result revealed homoscedastic errors. The Breusch-Godfrey test was used and there is no error auto-correlation of order one.

For predicting the indicator in 2013, another model is used:

$$\ln\_Iexp_t = 0.051 + 0.948 \cdot lnIimp_{t-1} - 0.0126 \cdot \frac{1}{lnIm_{t-1}} \quad \text{(E2)}$$

Forecasts of exports index on the horizon 2011-2013 Table 3

Year	Forecast
2011	1.25918
2012	1.19113
2013	1.17425

The exports index forecasts decrease from one year to another on the horizon 2011-2013. The average exports index is approximately 1.207, the predicted value for 2013 diminishing by 6.745%.

3.2. The evaluation of forecasts accuracy

In economic crisis, the performance decreases, the necessity of assessing the performance growing. The forecasts accuracy is a very large domain of research, an exhaustive presentation of it being impossible.

$\hat{X}_t(k)$ is the forecasted value after k time periods compared to the origin time t. The error at a future time (t+k) is: $e_t(t+k)$ being computed as the difference between the effective value and the predicted one.

Some accuracy indicators are computed for the predictions based on econometric models:

Root Mean Squared Error (RMSE)

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

Mean error

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

A positive value of ME implies low average predictions, while a negative one supposes overestimated values.

Mean absolute error (MAE)

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

These measures of accuracy have some disadvantages. For example, RMSE is affected by outliers. These measures are not independent of the unit of measurement, unless they are expressed as percentage. These measures include average errors with different degrees of variability. The purpose of using these indicators is related to the characterization of distribution errors.

Theil (1966) proposed the calculation of U statistic that takes into account both changes in the negative and the positive sense of an indicator:

U Theil's statistic can be computed in two variants.

The following notations are used:

a- the registered results

p- the predicted results

t- reference time

e- the error (e=a-p)

n- number of time periods

U1 Theil's coefficient used to compare two forecasts based on the same method or based on different forecasting methods.

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

A value close to zero for U_1 implies a higher accuracy.

U2 Theil's coefficient used to make comparisons between our forecasts and naive predictions.

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

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.

Ex-ante accuracy measures for forecasts in 2013 of exports and imports indices Table 4

Accuracy indicator	Imports index forecasts based on:		Exports index forecasts
	I1 model	I2 model	
Error	-0.00666	-0.00936	0.01274
Absolute error	0.00666	0.00936	0.01274
Percentage error	0.00561	0.00788	0.01073
U1 Theil's coefficient	0.00280	0.00392	0.00539

All the forecasts evaluations for 2013 are made under the assumption of keeping the same value registered in 2012. For imports index in 2013, we estimated an error of around 0.56% of the value registered in 2012. An underestimation of exports is anticipated for 2013, if the naive forecast is the reference. We appreciate that our prediction will be by 1.07% greater than the value registered for 2012 on the average.

Accuracy indicators for imports and exports indices (horizon: 2011-2012) Table 5

Accuracy indicator	Imports index forecasts based on:		Exports index forecasts
	I1 model	I2 model	
ME	-0.0117	-0.01304	-0.0336
MAE	0.01170	0.01304	0.0336
RMSE	0.01230	0.01454	0.0448
U1	0.00513	0.00607	0.0185
U2	1.07141	1.26790	3.8677

A persistent overestimation of the imports and exports index predictions was noticed for 2011-2012, the naive forecasts outperforming them. All the accuracy measures indicate that the imports based on I1 model are more accurate than those based on I2 model.

4. Conclusions

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

The present economic crisis that was explained only by arguments related to forecasts uncertainty determined 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 between the econometric model and the prediction based on it. In fact, the accuracy assessment helps us improve the econometric model, but also the forecasting process itself.

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