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Prediction of GDP Based on the Lag Economic Indicators

Alina Stundziene

Kaunas University of Technology
K. Donelaicio st. 73, LT-44029, Kaunas, Lithuania
E-mail. alina.stundziene@ktu.lt

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There are several institutions that constantly announce their predictions of general domestic product (GDP) and lots of institutions that use this information. Frequently the forecasts of different institutions vary because they use different methods, but all the institutions for which this indicator is relevant cannot make the predictions themselves because the models are too sophisticated. The main purpose of this research is to create simple enough but also accurate model for prediction of Lithuanian GDP that can be used by all the institutions that need this indicator. The research is based on the economic data that are measured and published quarterly or monthly by Statistics Lithuania. 154 economic indicators were analysed as possible independent variables for regression model creation. The analysis showed that the regression model with twelve lag independent variables can be quite accurate for a short-term prediction of Lithuanian GDP. It can be forecasted by such indexes as the number of immigrants, the turnover of wholesale and retail trade and repair of motor vehicles and motorcycles, the number of overnight stays in the accommodation establishments, an average hourly earnings, the rate of change in the producer prices of all the industry (except construction) of Lithuanian market, the imports and seasonally adjusted imports, the seasonally adjusted exports, the projected number of employees in the trade enterprises for the next 2–3 months, the industrial production (of all the industry except construction).

Keywords: *Lithuanian GDP, forecasting, model creation, regression models, lag models.*

Introduction

Prediction of the economic situation of the state is very important as the competitiveness and the performance results of the companies and all the state, human welfare and their living quality depend on the economics. But, unfortunately, it is not an easy task. Companies plan their performance, i.e. production, investments, number of employees according to the expectations of the state's economy. The government also takes into account the economic situation of the country when they plan the state's budget, the changes in tax system, investment and so on. According to their expectations people change they habits of consumption, choose between savings and investment, as well. From this can be concluded that the economic situation affects everybody.

Economic situation of the country can be described by various indicators and they cannot be analysed separately as they are related to one another, i.e. if one indicator changes the other indicators react as well. So regression analysis can be one of the possibilities to describe these relations (Stundziene, 2013).

Several institutions, for example state's central bank, commercial banks and some other organizations constantly announce their predictions of the main macroeconomic indicators, but frequently they vary between institutions as they employ different methods of forecasting. Unfortunately most companies and institutions for which the economic indicators are relevant are not able to predict them because the forecasting models are too sophisticated.

The object of this article is to create the relatively simple and appropriate model for prediction of Lithuanian GDP that can be used for each institution or a person who needs this information. There are several Lithuanian researchers who try to make the reliable model for prediction of Lithuanian GDP using various techniques but still no one can be called as the best. Commonly two things must be coordinated: the precision of the model and its complexity. Usually the better prediction can be obtained by complicated model, but because of its complexity only a small part of stakeholders can use it, and on the contrary, if we use a simple model the precision of it is not sufficient (Stundziene, 2013). Thus, the goal of this article is to reconcile these two thinks.

The standard multiple linear regression model cannot always be the appropriate model for the prediction, because the dependent and the independent variables included into the model are measured at the same moment of time. So in order to forecast the dependent variable, previously the forecasts of independent variables must be done. For this reason the prediction of the dependent variable based on the predicted independent variables increases the errors of prediction. The task of this research is to find the accurate model which has the least number of independent variables that must be initially predicted and to maximize the usage of information of previous periods that is already known. This is the novelty of the research.

The research methods applied in this article are logical and comparative analysis of scientific literature, multiple linear regression models, distributed lag models, ARIMA models. The results of the research were obtained by one of the advanced statistical software packages EViews 8.

Methods Applied for Prediction of Economic Indicators

The basis for economical analyses at the decision-making level is focused on mathematical modeling of real economical phenomena (Chvatalova & Simberova, 2011). There are lots of methods used for modeling and prediction the economic indicators. Usually two kinds of prediction methodologies can be identified in the literature: the methods based on parametric modeling (for example linear autoregressive models, the non-linear, SETAR-STAR, Markov switching and other models), and the methods based on non-parametric techniques (for example Kernels method, nearest neighbour method, neural network, wavelet methods and others) (Guegan & Rakotomarolahy, 2010).

Times series models, usually ARIMA models, are applied for economic modelling in many countries, for example Taht (2008) has applied it for prediction of Estonian GDP, Turturean (2007) used it for prediction of Romanian GDP, Klucik & Juriova, 2010) forecasted Slovakian GDP, (Andrei & Bugudui, 2011) applied it for US economy and so on. European Central Bank also uses these models (Barhoumi *et al.*, 2008).

The bridge equations method is another approach that combines linearity and aggregation (Diron, 2008). These models rely on a number of monthly indicators which are readily available and allow to project macroeconomic indicators over the time. In general, these models are used for short-term predictions, i.e. for one or two quarters. The approach relies on selected qualitative and quantitative monthly indicators and on the specification of a statistical equation that links these indicators with the quarterly series that has to be projected. If the information on the indicator is not available for all months of the quarter (for all forecasting horizon) then a preliminary projection of the monthly indicator is conducted. This is done by the means of other indicators or through autoregressive models (ARIMA) projecting the monthly indicator on the basis of its past dynamics (Baffigi *et al*., 2004).

Bridge equations are used by many institutions and have been studied in various papers (Baffigi *et al*., 2004; Runstler & Sedillot, 2003; Barhoumi *et al*., 2008; Angelini *et al.*, 2008). Central Banks widely use the results of Diron's (2008) research. Her method is based on a limited number of economic indicators that are plugged in eight linear equations from which an estimate of GDP is obtained. Her method associates the bridge equations and forecasts combinations incorporating a large number of economic activities including different single forecasts based on survey data, production sectors, financial variables and leading index constructed from large number of economic indicators. Her method is competitive comparing with the methods that include a huge number of indicators.

Traditional bridge equations can handle only few variables. Recently, Giannone and others (2004, 2005) have proposed to use the factors extracted from the large monthly datasets to perform bridging which exploit a large number of indicators within the same model (bridging with factors). They propose to use the Kalman filter to estimate the factors and handle the missing data, but alternative estimation methods also can be used.

Prediction of GDP can be also made by factor models, for example (Camacho & Martinez-Martin, 2012) used it for prediction of US economics, (Cheung & Demers, 2007) applied it for prediction of Canadian GDP, (Schumacher, 2005) used it for prediction of German GDP. Methods that have been used in the Eurosystem include the principal component estimator of the factors (Stock & Watson, 2002) and the frequency domain-based two-step estimator of Forni and others (2005).

Runstler and others (2008) considered a range of models, including the traditional bridge equations and the dynamic factor models. The main finding obtained for the euro area countries was that bridge models, which timely exploit monthly releases, fare considerably better than quarterly models and dynamic factor models, which exploit a large number of releases, do generally better than the traditional bridge equations.

Recently the dynamic stochastic general equilibrium models (DSGE) are often used for prediction of GDP (Smets & Wouters, 2004). Today they are mostly employed for the evaluation of economic policy. The general equilibrium models can be applied in such spheres as the money policy, taxes, international trade, the policy of state's investments, employment problems, the qualification of labour force, regional development, application of new technologies, integration in economic unions, control of protection of nature and others (Tamosiunas, 1999). Nevertheless, the practical experience of using modern DSGE models for the scenario analysis in the policymaking institutions is relatively limited and diverse across the individual institutions. Still, the adoption of the DSGE approach is an ongoing process and there is much to be learned about the design, implementation and communication of DSGE model-based scenario analysis.

As the researches of scientists show that modeling by DSGE models is not yet satisfactory, a lot of national central banks continue to use the traditional macroeconomic models along with the DSGE models, thus recognizing advantages and limitations of both modeling approaches. The linear ARIMA or VAR models remain the benchmarks in the literature.

It is impossible to find the perfect model for the prediction of economic indicators because of the uncertainty. Uncertainty plays an important role in many areas of economic behaviour that's why uncertainty is also inherent to forecasting (Boero *et al.*, 2008; Laurent & Kozluk, 2012). Bratu (2012) states some important strategies that can be used in practice in order to improve the accuracy of forecasts. 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 correlation matrix, the use of regression models for the large databases of predicted and effective values. On the other hand, one can apply the historical errors method, which implies the same value of an accuracy indicator calculated for a previous period.

Model building is a hard process. Many created models that are used by various institutions and individuals look quite good. But expectations are seldom rational, and when it becomes clear that the model is not the panacea that can cure all the ills of a business, some disillusion set in. As there is no method that can be called as the best one, many countries build a set of different models for prediction of GDP. For example ARIMA models with the seasonal components and indicator models, similar to the bridge models are used in Albania (Celiku *et al*., 2009).

The Experience in Prediction of Lithuanian GDP

There are a lot of discussions of macro-econometric modeling alternatives and specificity of modeling the Lithuanian economy. Lithuania has only few developed macro-econometric models, which are able to make the forecasts. One is used by the government and others are used by several banks (Stankeviciene *et al.*, 2012). Institute of Economics with the help of other institutions has built a medium-sized macro-econometric sectoral model of the Lithuanian economy called LITMOD. The key point of the model is a 12-sector input-output table of the Lithuanian economy facilitating analyses of structural changes (Celov *et al.*, 2005).

Various individual researches in prediction of Lithuanian GDP can also be found. For example Virbukaite (2011) has employed VAR method for the prediction of Lithuanian GDP. Although the model was quite accurate, the main shortage of the research is that endogenous variables were chosen by herself not by the correlation analysis. (Ruksenaite, 2010) made the analysis of 41 indicators given from Lithuania Statistics in order to say which are the most related with GDP. She pointed that the turnover of retail trade, except of motor vehicles and motorcycles, car fuel trade, export and turnover of retail trade in food and beverage service are the most correlated indicators with GDP.

(Vilkas, 1997; Tamosiunas, 1999) were the first who applied DSGE model for Lithuanian economics. (Karpavicius, 2008) has properly calibrated the DSGE model for recent Lithuanian data. In 2009 he has also examined the effects of the fiscal instruments, namely labor tax, consumption tax, capital tax, transfers to households, and government spending, on Lithuanian economy and welfare assuming balanced government budget using DSGE model. Together with (Vetlov, 2008) he had analyzed the economics' impact of the 2006–2008 personal income tax reform in Lithuania.

Maintaining an econometric model of the economics requires a proper management of huge amount of information, trained and highly skilled personnel abilities to deal with complex computations and persisting problems, and good knowledge of the countries' macro economics. This is one of the main reasons why there are only few models of prediction of Lithuanian GDP that are used nowadays and one of the reasons to develop a new one, which will provide a sophisticated approach to the future scenarios of the economy, which can be analyzed afterwards.

The Background of a New Model for Prediction of Lithuanian GDP

Any created model for prediction of Lithuanian GDP still cannot be called as the best. The previous researches made by (Stundziene, 2013) showed that regression model is better than time series model for prediction Lithuanian GDP. After the analysis of 154 economic indicators measured and published monthly by Statistics Lithuania showed that the best multiple linear regression model that can be applied for prediction of Lithuanian GDP is

$$Y = 0.002826 \cdot X_{127} + 0.473039 \cdot X_{147} + 4.573546 \cdot X_{153}. \quad (1)$$

Here Y is GDP, X_{127} is the turnover (VAT excluded) of retail trade, except of motor vehicles and motorcycles, at current prices (in thousand LTL), X_{147} is the goods loading in seaports (in thousand tones) and X_{153} is the passenger arrivals and departures at airports (in thousands). The precision of this model is 98,4 % and it satisfies all the assumptions required for the regression model.

Hence, in order to predict the GDP using the (1) model, three other indicators (the turnover of retail trade, except of motor vehicles and motorcycles, goods loading in seaports and passenger arrivals and departures at airports) must be initially predicted for the same quarter. This undoubtedly can cause the greater forecasting errors comparing with the prediction of GDP when the values of independent variables are not predicted, but real (known).

That's why another question was raised: *can lag values of the indicators improve the precision of the model*?

Correction of the Model Including Lag Values

The creation of the better regression model was based on the data that are measured and published monthly and quarterly by Statistics Lithuania in order to exploit the opportunity to employ the newest information. 154 ratios were analyzed as the potential independent variables. All they can be grouped as macroeconomics data, population and social statistics, business statistics, trade and transport statistics. The model was made for the sample of the data of the period of 2004–2012 years.

The dependency between GDP and all other independent variables was analysed not only for the current quarter but also the information of past one, two, three, four, five and six quarters was evaluated. Stepwise-forwards regression method was chosen for regression model creation and the aim was to find the model with not more then 10 independent variables. It was long procedure to find an appropriate model because of several problems encountered:

- Several economic indicators used in these researches were calculated in the base of 2005 year, but recently Lithuanian Statistics changed the base from 2005 year to 2010 year. In order to maintain the relevance and usefulness of the created model, the values of these ratios were also upgraded in this research. As the result the significance of these indicators has changed and the structure of the whole model also became different.

- Lag length l=5 and l=6 was not significant for most of indicators, that's why they were given up from the further analysis.
- Several models were not suitable because independent variables were multicollinear.
- Lots of significant models were rejected because the residuals of the models were correlated.
- Several regression models were rejected because they were spurious regression. In order to avoid such situation the stationarity of each indicator was tested. Then differentiation was applied for each indicator that was not stationary.

After lots of steps and repetitions of the procedure an appropriate model was found. It can be written by the following equation:

$$\begin{aligned} Y = {} & 0.002890 \cdot X_{127} + 0.595479 \cdot X_{147}(-1) + 0.011538 \cdot X_{131} - \\ & - 0.002285 \cdot X_{132}(-4) + 1246.651101 \cdot \Delta X_{35}(-3) - \\ & - 8.037355 \cdot \Delta X_{55}(-3) - 0.000167 \cdot \Delta X_{141}(-1) - \\ & - 0.103399 \cdot (X_{97}(-2))^2 - 0.000440 \cdot X_{125}(-3). \end{aligned} \tag{2}$$

Here Y is GDP, X_{127} is the turnover (VAT excluded) of retail trade, except of motor vehicles and motorcycles, at current prices (in thousand LTL), $X_{147}(-1)$ is the goods loading in seaports in the previous quarter (in thousand tones), X_{131} is the number of tourists accommodated, $X_{132}(-4)$ is the number of overnight stays in the accommodation establishments in the same quarter of the previous year, $\Delta X_{35}(-3)$ is the change of average hourly earning three quarters ago comparing with the previous quarter ($\Delta X(-3)$ is the same as ΔX_{t-3} and $\Delta X_{t-3} = X_{t-3} - X_{t-4}$), $\Delta X_{55}(-3)$ is the change of consumer expectations about the price trends over the last year three quarters ago comparing with the previous quarter, $\Delta X_{141}(-1)$ is the change of imports (in thousand LTL) one quarter ago comparing with the previous quarter, $(X_{97}(-2))^2$ is the squared ratio of projected number of employees of trade enterprises for the next 2-3 months two quarters ago, $X_{125}(-3)$ is the turnover (VAT excluded) of wholesale and retail trade and repair of motor vehicles and motorcycles at current prices (in thousand LTL) three quarters ago.

All parameters of the (2) model are significant and the adjusted coefficient of determination of the model is 0.9948. The residuals of the model satisfy all the assumptions: the mean of the residuals is close to 0, they are distributed by normal distribution, homoscedastic and do not correlate with each other.

As the precision of this model is high, another question was raised: *is it possible to reduce the number of independent variables in the regression model (to make it simpler) preserving sufficient accuracy*?

Reduction of the Number of Independent Variables in the Model

Stepwise-forwards method was also chosen for creation of simpler model just one more stopping criteria for the procedure was added (Startz, 2013). It is the number of independent variables included into the model. A new significant model was found when the number of independent variables was reduced till 6. The equation of a new model is presented bellow:

$$\begin{aligned} Y = {} & 0.002535 \cdot X_{127} + 0.473257 \cdot X_{147}(-1) + \\ & + 0.016051 \cdot X_{131} - 0.004189 \cdot X_{132}(-4) + \\ & + 0.000449 \cdot X_{127}(-4) - 26.201389 \cdot \Delta X_{55}(-3). \end{aligned} \tag{3}$$

Five independent variables in (3) model are the same as they were in the (2) model, but one new variable was added. It is $X_{127}(-4)$ that shows the turnover (VAT excluded) of retail trade, except of motor vehicles and motorcycles in the same quarter of the last year, at current prices (in thousand LTL). The adjusted R^2 remained high and it is 0,990 and the residuals of the model satisfy all the requirements.

The simplest regression model that can be got by stepwise regression method consist of four independent variables and the adjusted R^2 is equal to 0.982. The equation of this model is written below:

$$\begin{aligned} Y = {} & 0.002762 \cdot X_{127} + 0.625335 \cdot X_{147}(-1) + \\ & + 0.009522 \cdot X_{131} - 0.002000 * X_{132}(-4). \end{aligned} \tag{4}$$

Stepwise-forwards method is not the only for regression model creation, so another question arose: *can other method submit the better model?*

Improvement of the Models

Swapwise – Max R-squared method was also implemented for regression model creation in order to test whether the better model can be found. A new regression model with six independent variables was found as a suitable model for prediction of Lithuanian GDP. The equation of this model is presented below:

$$\begin{aligned} Y = {} & 0.002747 \cdot X_{127} + 0.605133 \cdot X_{147}(-1) + \\ & + 0.012961 \cdot X_{131} - 0.002886 \cdot X_{132}(-4) - \\ & - 0.000156 \cdot \Delta X_{141}(-1) - 41.644188 \cdot \Delta X_{55}(-3). \end{aligned} \tag{5}$$

This model is similar to the (3) model created by stepwise forward method, just in the (5) model index $X_{127}(-4)$ is changed by $\Delta X_{141}(-1)$. $\Delta X_{141}(-1)$ is the change of imports (in thousand LTL) one quarter ago comparing with the previous quarter. The precision of such model slightly increases. The adjusted R^2 of the (5) model is 0.9917.

If variable $\Delta X_{35}(-3)$ is also included in the model, the adjusted R^2 increases more and seeks 0.9932. Residuals of such model also satisfy the assumptions and this model can be used for prediction. The equation of this model is presented below:

$$\begin{aligned} Y = {} & 0.002653 \cdot X_{127} + 0.645268 \cdot X_{147}(-1) + 0.013344 \cdot X_{131} - \\ & - 0.002887 \cdot X_{132}(-4) - 0.000160 \cdot \Delta X_{141}(-1) - \\ & - 48.087738 \cdot \Delta X_{55}(-3) + 1050.556763 \cdot \Delta X35(-3). \end{aligned} \tag{6}$$

Swapwise – Max R-squared method also shows that if index $\Delta X_{141}(-1)$ in the (2) model is changed by the index $X_{127}(-3)$ the precision of the model can also be higher. The adjusted R^2 of such model is 0.9963 and the equation of the model is written below:

$$\begin{aligned} Y = {} & 0.002947 \cdot X_{127} + 0.319257 \cdot X_{147}(-1) + 0.013633 \cdot X_{131} - \\ & - 0.003680 \cdot X_{132}(-4) + 0.000666 \cdot X_{127}(-3) - \\ & - 25.869747 \cdot \Delta X55(-3) + 855.921759 \cdot \Delta X_{35}(-3) - \\ & - 0.162316 \cdot (X_{97}(-2))^2 - 0.001031 \cdot X_{125}(-3). \end{aligned} \tag{7}$$

In all created models the prediction of GDP can be done only if the values of variables X_{127} and X_{131} of the same quarter are known, so initially these ratios must be predicted.

Prediction of Independent Variables

In the creation of regression models for the prediction of X_{127} and X_{131} various lag values of independent variables were used in the models in order to avoid the prediction of new variables.

Swapwise – Max R-squared method was used for model creation as it lets choose the number of independent variables included into the model. It is necessary in order to achieve the appropriate precision of the model. Unfortunately, the appropriate regression model with not more than 10 independent variables was not found. The main problem was the existence of autocorrelation between model residuals. That's why ARIMA model was tested.

X_{127} is stationary time series when constant is included, and the best ARMA model for this time series is ARMA(5,5). But the precision of such model is only 94%, that's why this time series was differenciated and ARIMA model was sought. Unfortunately, no one ARIMA(p,d,q) model with any p,d, q values could improve the precision.

X_{131} is stationary time series when constant and linear trend is included and the best ARMA model for this time series is ARMA(5,1). The precision of such model is 97% and it is also not sufficient. ARIMA(p,d,q) model with any p,d, q values could not improve the result as the residuals of these models did not satisfy the requirements.

Correction of the Model by Changing the Independent Variables With Lag Values

As it was impossible to find the accurate model for prediction of X_{127} and X_{131}, an alternative model was created. The (2) model was modified and a new regression model for prediction of GDP was created including only lag variables into the model in order to avoid the prediction of independent variables. The appropriate model is presented below:

$$\begin{aligned} Y = {} & 689.557813\cdot\ln(X_{30}(-2)) + 0.003333\cdot X_{125}(-1) + \\ & + 0.555177*Y(-4) - 0.002134\cdot X_{125}(-3) - \\ & - 0.002395\cdot X_{132}(-2) + 1631.688958\cdot\Delta X35(-1) + \\ & + 158.825776\cdot\Delta X_{13}(-1) + 0.000669\cdot X_{142}(-2) + \\ & + 0.125023\cdot(X_{97}(-4))^2 - 0.000288\cdot X_{140}(-3) - \\ & - 0.000407\cdot\Delta X_{112}(-3) + 0.000207\cdot\Delta X_{141}(-3) \end{aligned} \tag{8}$$

Here Y is GDP, $\ln(X_{30}(-2))$ is logarithm of number of immigrants two quarters ago, $X_{125}(-1)$ is the turnover (VAT excluded) of wholesale and retail trade and repair of motor vehicles and motorcycles at current prices (in thousand LTL) of the previous quarter, Y(-4) is GDP of the same quarter of the previous year, $X_{125}(-3)$ is the turnover (VAT excluded) of wholesale and retail trade and repair of motor vehicles and motorcycles at current prices (in thousand LTL) three quarters ago, $X_{132}(-2)$ is the number of overnight stays in the accommodation establishments two quarters ago, $\Delta X_{35}(-1)$ is the change of average hourly earning one quarter ago comparing with the previous quarter ($\Delta X(-1)$ is the same as ΔX_{t-1} and $\Delta X_{t-1} = X_{t-1} - X_{t-2}$), $\Delta X_{13}(-1)$ is by the same principle calculated the difference of the rate of change in producer prices of all the industry (except the construction) of Lithuanian market compared to corresponding quarter of the previous year, $X_{142}(-2)$ is the seasonally adjusted imports (in thousand LTL) two quarters ago, $(X_{97}(-4))^2$ is the squared ratio of projected number of employees of trade enterprises for the next 2-3 months four quarters ago, $X_{140}(-3)$ is the seasonally adjusted exports (in thousand LTL) three quarters ago, $\Delta X_{112}(-3)$ is the change of industrial production (of all industry except construction, VAT and excises excluded) at current prices (in thousand LTL) three quarters ago comparing with the previous quarter, $\Delta X_{141}(-3)$ is the change of imports (in thousand LTL) tree quarters ago comparing with the previous quarter.

The precision of this model is the highest comparing with other created models and the adjusted R2 of the model is 0.9966. The conformity of the calculated by the (8) model values with the real values of GDP and the residuals of the model are shown in the *Figure 1.*

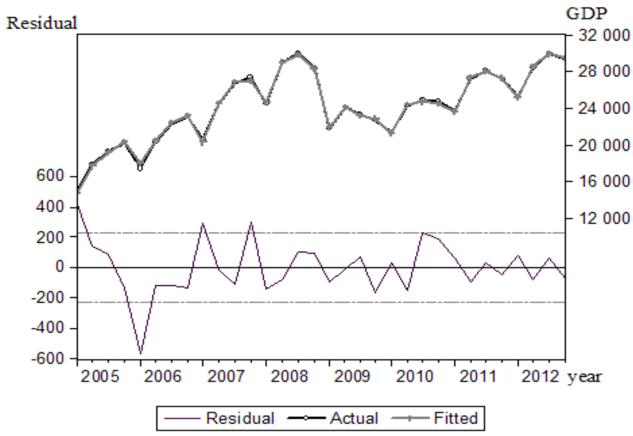

Figure 1. The comparison of the real values of GDP (million LT) with calculated by the (8) model and the residuals of the model (created by the author using EViews 8)

As the real GDP of a quarter is calculated for the several times by Lithuanian Statistics and the real GDP can be known only after more than one year, so the latest real values of GDP also can be inaccurate. Looking at the statistics that was published by Lithuanian Statistics and that is published now there can be observed that all the values of GDP starting from the first quarter of 2010 year are different and the difference between these values varies from 0,1% to 1,7%. So this rate was the measure of the precision of the model created by myself. All the residuals of the model (8) don't exceed this interval except the residuals for the first quarter of 2005 and the first quarter of 2006 year. As these values are in the beginning of the sample and the model fits the latest values very well, this fact can be assumed as less important and the model considered as an acceptable.

Prediction of Lithuanian GDP

The (8) model was used for prediction of Lithuanian GDP for each quarter of 2013 and the first quarter of 2014. The results are presented in the *Table 1.*

Table 1

Comparison of predicted values of Lithuanian GDP calculated by the (8) model with the real values of GDP

Period	GDP published by Lithuanian Statistics, million Lt	GDP calculated by the created model, million Lt	Tolerances, %
2013Q1	26497,8	28532,12	-7,68 %
2013Q2	30192,4	31523,02	-4,41 %
2013Q3	32193,4	31849,58	1,07 %
2013Q4	30585,5	30426,89	0,52 %
2014Q1	-	29407,8	-

The results show that the precision of prediction for the first two quarters of 2013 is not passable and it is acceptable only for the last two quarters of 2013. The analysis of the data showed that high tolerance was largely caused by the sudden upsurge of immigration in the middle of 2012. The number of immigrants rose to 6524 in the third quarter of 2012 and the analysis of box-plot of this indicator showed that it is an outlier. Later the number of immigrants decreased that's why the precision of the model increases. The prediction of GDP for the first quarter of 2014 can also be inaccurate as the number of immigrants in the third quarter of 2014 increased even more and amounted 8105. As this indicator has quite strong positive relationship with GDP, the calculated GDP for the first quarter of 2014 is probably too large.

Attempts were made to improve the model by adding the data of the first quarter of 2013 into the sample for the model creation, but the increased sample did not let find the better model that could reduce the residuals for the first quarter of 2013.

Conclusions

Macroeconomic indicators, GDP as well, are subject to important differences in publication lags. Official estimates of GDP growth are released with a considerable delay. Preliminary evaluation of previous quarter is published after month and exact evaluation is notified only after four months. Moreover the estimated of GDP can be adjusted even several years. That's why it is important to have a tool that let the companies or the persons to make the prediction of GDP themselves.

The created model for prediction of Lithuanian GDP is useful and comfortable because it uses the information of previous quarters that are known and must not be predicted. The research showed that Lithuanian GDP can be forecasted by twelve lag independent variables. They are the number of immigrants two quarters ago, the turnover (VAT excluded) of wholesale and retail trade and repair of motor vehicles and motorcycles at current prices (in thousand LTL) of the previous quarter, GDP of the same quarter of the previous year, the turnover (VAT excluded) of wholesale and retail trade and repair of motor vehicles and motorcycles at current prices (in thousand LTL) three quarters ago, the number of overnight stays in the accommodation establishments two quarters ago, the change of average hourly earning one quarter ago comparing with the previous quarter, the difference of the rate of change in producer prices of all the industry (except the construction) of Lithuanian market compared to corresponding quarter of the previous year, the seasonally adjusted imports (in thousand LTL) two quarters ago, the squared ratio of projected number of employees of trade enterprises for the next 2–3 months four quarters ago, the seasonally adjusted exports (in thousand LTL) three quarters ago, the change of industrial production (of all industry except construction, VAT and excises excluded) at current prices (in thousand LTL) three quarters ago comparing with the previous quarter and the change of imports (in thousand LTL) tree quarters ago comparing with the previous quarter.

The simplicity and accuracy of the model is another advantage of the created model. It is much simpler than the methodology that Lithuanian Statistics or other state's institutions use and the accuracy of the prediction made by this model is similar to the accuracy of the prediction made by Lithuanian Statistics. Ensuring the relevance of the model the situation of immigration in the country must be monitored. If it will stabilize, the model will be accurate, but if the immigration in Lithuanian continues to increase, the model will have to be re-estimated.

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