Forecasting Gross Domestic Product of the Philippines using Vector Error Correction Models

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ABSTRACT

This study uses a Vector Error Correction Model as a tool for research to analyze and determine the characteristics of Gross Domestic Product (GDP) of the Philippines. Import of goods and services (import) and export of goods and services (export) are considered as influencing variables for the Gross Domestic Product of the Philippines. Quarterly data of GDP, import and exports from 1998 to 2016 were used in the study. All calculations were done using the free software JMulti. The three variables are found to be cointegrated with at most 1 rank. and the optimal number of lags is found to be 5. Furthermore, it was found out that both in the long run and short run, import has a positive impact on GDP while export has a negative impact on GDP. Based on the results of the diagnostic checks, the formulated vector error correction (VEC) model is an appropriate model for the data. Also, the generated forecasts using the VEC model are close to the actual values of the GDP. Thus, the formulated VEC model can be used for forecasting the GDP of the Philippine.

Keywords*: multivariate time series analysis; Philippine economy; vector error correction model; JMulti.*

INTRODUCTION

In the area of macroeconomics, analyzing key macroeconomic variables is part of the large component of the work in applied economic analysis (Pilstrom & Pohl, 2009). One of these variables is the Gross Domestic Product (GDP) Rate. Forecasting the future course of the GDP Rates is important since it is used to gauge the health and economic performance of a country. GDP Rates also represents the total dollar value of all goods and services produced over a specific time period, often referred to as the size of the economy. Other macroeconomic variables have been studied to see their relationship to GDP Rates. Export and Import of goods and services are found to be influential in the growth of GDP (Saaed, 2015).

Large datasets such as those found in government websites, can be analyzed in order to revisit existing policies and to explore possibilities of creating a better one. According to Alam (2011), because of the contribution of trade to the national income growth, international trade (export and import) is an element of GDP expansion. The study of Saaed and Hussain (2015) revealed that the source of economic development in Tunisia was contributed mostly by imports. On the other hand, Li, Greenaway and Hine (2003) suggested that for the developed countries, importing of goods and services has a good and positive contribution to their country's GDP but a negative impact on the countries that are still developing. Albiman and Sulelman (2016) examine whether there is a dynamic relationship among economic growth, export and import. The result of the study shows a positive long run relationship among the variables. The study of

Bakari (2017) reveals that in the long run, export and investments have a negative effect on economic growth.

In this paper, the aim is to know if there is long run and short run causality running from the import of goods and services and export of goods and services to the gross domestic product of the Philippines and to create a VEC model to forecast the GDP of the Philippines.

METHOD

The data needs to be transformed into its logarithmic form in order to clearly see the relationship of the variables. Given a time series Y_t the log transform value is given by $Z_t = \log(Y_t)$. The vector error correction model is a type of Vector Autoregressive (VAR) models where the variables are not stationary, but their first difference is. To test the stationarity of the variables, the Augmented Dickey Fuller Test was used.

The Johansen cointegration test was used to determine whether the variables GDP, Import and Export are cointegrated. The null hypothesis of the test is that the cointegrating rank among the variables is equal to 0. The Schwarz Criterion Procedure was used for estimating the model using its optimal number of lags.

The Vector Error Correction Model for this study takes the form

$$\begin{bmatrix} y_{1,t} \\ y_{2,t} \\ y_{3,t} \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \end{bmatrix} [\beta_1 \quad \beta_2 \quad \beta_3] \begin{bmatrix} y_{1,t-1} \\ y_{2,t-1} \\ y_{3,t-1} \end{bmatrix} + EF + \begin{bmatrix} s_{1,1}^p & s_{1,2}^p & s_{1,3}^p \\ s_{2,1}^p & s_{2,2}^p & s_{2,3}^p \\ s_{3,1}^p & s_{3,2}^p & s_{3,3}^p \end{bmatrix} \begin{bmatrix} y_{1,t-p} \\ y_{2,t-p} \\ y_{3,t-p} \end{bmatrix} + \begin{bmatrix} e_{1,t} \\ e_{2,t} \\ e_{3,t} \end{bmatrix}$$

where $y_{1,t}$- Gross Domestic Product, $y_{2,t}$- Exports of goods and services, $y_{3,t}$- Imports of goods and services, p - lag order, β - cointegrating relation coefficients, $s_{i,j}^p$ - coefficients of the p^{th} lag order, EF - Parameter matrices.

The Breush-Godfrey LM Test was used in testing the residual autocorrelation of the model. It tests the null hypothesis of no autocorrelation among the residuals of the model. The residual has no serial correlation if the null hypothesis is not rejected. On the other hand, the Multivariate LM Test was used in testing the presence of conditional heteroscedasticity in the residuals of the model. Rejection of the null hypothesis implies that heteroscedasticity is present in the residuals.

The Chow Test is a test of whether the true coefficients in two linear regressions on different data sets are equal. Basically, it tests whether one regression line or two separate regression lines best fit a split set of data.

The Granger Causality Test was done in order to examine the ability of one variable to predict another variable. It is a statistical concept of causality that is based on prediction. In the case of two variables, Y_t is said to be Granger-caused by X_t if the past values of X_t helps in the prediction of the future values of Y_t that is if the coefficients on the lagged X_t are statistically significant.

Impulse Responses was done to analyze the dynamic interactions between the variables and in order to trace out how shocks will affect a variable through time. On the other hand, Forecast Error Vector Decomposition (FEVD) was used to determine which shocks are most important in explaining a variable through time.

RESULTS

Figure 1 shows the characteristics of the GDP of the Philippines from year 1998 to 2016. It shows that the country's GDP has an increasing trend. In 2016, the values increase and reaches 4.2%.

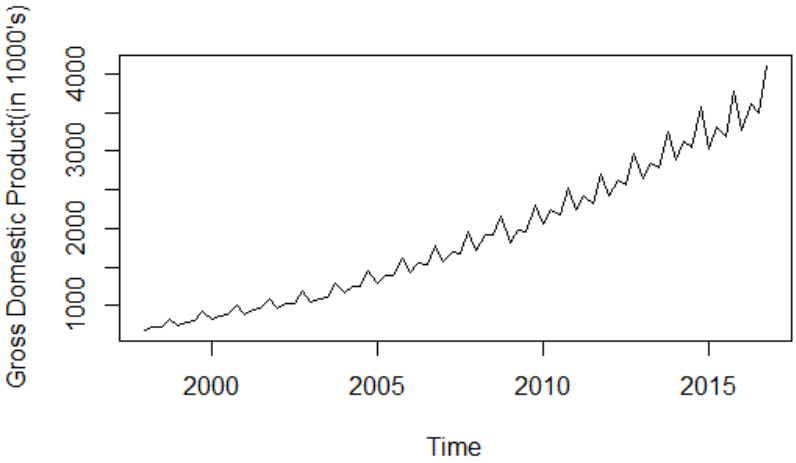

Figure 1. Quarterly Gross Domestic Product of the Philippines

Based on Figure 1, the variance of the series is assumed to be non-constant, thus, log transformation was done. Figure 2 shows the time series plot of the log transformed data.

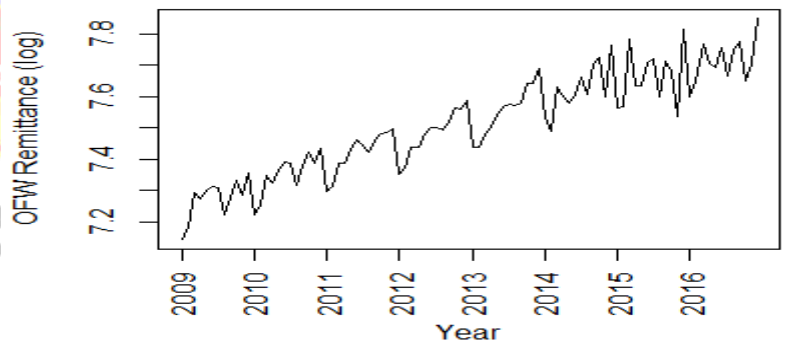

Figure 2. Monthly OFW Remittance in the Philippines (Log transformed)

Moreover, the figure shows that the time series data is not stationary since it is shown in the plot that the series does not fluctuate near its mean value. To formally test whether the series is stationary, the Augmented Dickey fuller test was used. At 0.05 level of significance the null hypothesis of stationarity is rejected. Therefore, the data is non-stationary. Results of the test are summarized in Table 1.

Table 1. Result for the ADF test for stationary

Variables	ADF test statistic	Critical value	Remarks
GDP	4.62	-1.94	Nonstationary
Export	2.32	-1.94	Nonstationary
Import	-2.55	-1.94	Nonstationary

To make the series stationary, transformation using first differencing was applied to the data. The Augmented Dickey Fuller test was performed on the differenced data. The result is summarized in Table 2. The test statistic for the three variables are all less than -1.94 which is the critical value. Hence, the three variables are all stationary.

Table 2. Test for Stationary the Differenced series

Variables	ADF test statistic	Critical value	Remarks
GDP	-8.89	-1.94	stationary
Export	-7.82	-1.94	stationary
Import	-5.82	-1.94	stationary

Since all the variables are stationary, we can now proceed to test if the variables are cointegrated. The result of the test is presented in Table 3.

Table 3. Cointegration Test

Maximum Rank	Test statistic	Critical Value	p-value
At most 0	38.29	35.07	0.0208*
At most 1	17.80	20.16	0.1059
At most 2	4.55	9.14	0.3475

At 5% level of significance the null hypothesis of no cointegration is rejected (38.29 > 35.07) for the rank with at most 0. However, for the rank with at most 1, the null hypothesis cannot be rejected. Thus, it was found out that there is at most 1 cointegrating vector among the variables (17.80 < 20.16). Moreover, if there is one or more cointegration found in the model, there exists a long run relationship among the variables. The optimal number of lags is determined using Schwarz Information Criterion. In this study, the Schwarz criterion produced 5 lags. Hence lag=5 is chosen as the optimal number.

The long run equation for GDP is given as

$$\ln(GDP) = 1.596\ln(import) - 3.219\ln(export) + 5.654$$

The long run equation shows the positive direct relationship of import of goods and services to the Gross Domestic Product of the Philippines. Moreover, it also says that for every 1% increase in import of goods and services, GDP is increased by 1.596\%. The result may be attributed by the import of capital goods and services mainly in the agriculture, industry and transport sector (Maina, 2015). On the other hand, Export have a negative long run relationship to the values of GDP. Thus, for every 1% increase in the Export, it is most likely to decrease GDP by 3.219%. The short run equation is given as

$$\begin{aligned}\Delta\ln(GDP) = {} & -0.028ECT - 0.022\Delta\ln(GDP_{t-1}) + 0.51\,\Delta\,\ln(Import_{t-1}) - 0.070\,\Delta\ln(Export_{t-1}) \\ & - 0.483\Delta\ln(GDP_{t-2}) + 0.59\,\Delta\,\ln(Import_{t-2}) - 0.043\,\Delta\ln(Export_{t-2}) \\ & - 0.476\Delta\ln(GDP_{t-3}) + 0.032\,\Delta\,\ln(Import_{t-3}) - 0.044\,\Delta\ln(Export_{t-3}) \\ & + 0.514\Delta\ln(GDP_{t-4}) + 0.044\,\Delta\,\ln(Import_{t-4}) - 0.013\,\Delta\ln(Export_{t-4}) \\ & - 0.480\Delta\ln(GDP_{t-5}) - 0.038\,\Delta\,\ln(Import_{t-5}) + 0.006\,\Delta\ln(Export_{t-5}) - 0.157\end{aligned}$$

This equation shows that the coefficient of ECT is negative (-0.028) which indicates that the deviation from the long run equilibrium value is corrected in the next period automatically by 2.8%. Also, the coefficient of import of goods and services is positive in the first to third order lags, but it is negative in the fourth to fifth order lags means that higher import of goods and services will slightly increase the value of GDP. Whereas, the coefficient of export of goods and services are negative in the first to fourth order lags which implies that in the short run higher export of goods and services will decrease the value of GDP.

The model was also examined whether autocorrelation (Table 4) and heteroscedasticity (Table 5) exist among its residuals and found out that there is no autocorrelation among the residuals and the model is adequate enough for prediction and forecasting. Based on Table 4 the p-value of the test is 0.1357 which is greater than the level of significance at 0.05. Hence, the null hypothesis of no autocorrelation is not rejected and it is safe to say that there is no autocorrelation among residuals.

Table 4. LM test for autocorrelations

Test statistic	p-value
55.01	0.1357

The result of Table 5 shows that there is no Autoregressive Conditional Heteroscedasticity (ARCH) effect present in the residuals of the model since the p-value is 0.7263 which is greater than the level of significance set at 0.05.

Table 5. LM test for heteroscedasticity

Test statistic	p-value
168.1817	0.7263

The vector error correction model may have issues with the stability brought about by the process of data generation. The Chow Test is used to determine the constancy and stability of the estimated model. The result in Table 6 show that the null hypothesis of the model stability is not rejected since the p-value is equal to 0.994 which is greater than 0.05. Thus, the model is empirically well behaved and is suitable for forecasting GDP rates for every feasible period.

Table 6. Chow test for stability

Test statistic	p-value
0.3039	0.995

According to Asteriou (2007), one good feature of the Vector Error Correction Models is that they allow testing the direction of causality. The null hypothesis of this test is import and export of goods and services do not granger-cause Gross Domestic Product rates of the Philippines. The result is shown in Table 7. The result shows that the p-value is equal to 0.0010 which means that the null hypothesis is rejected at 5% significance level, meaning that there is uni-directional causality among the variables.

Table 7. Granger Causality Test

Test statistic	p-value
2.9635	0.0010

The forecasted and actual values of time-series forecast for 2017 is presented in Table 8. The forecast of the VEC model is increasing from the first to the fourth quarter of 2017 which means that the forecasted values of GDP is appreciating over time. The model underestimated the values of GDP since the residuals are positive but minimal and not too far from the actual values.

Table 8. Test for Stationary the Differenced series

Quarter	Forecast	Actual Values	Residuals
1	15.0675	15.0901	0.0226
2	15.1638	15.1905	0.0267
3	15.1231	15.1547	0.0316
4	15.2901	15.3081	0.0180

CONCLUSION

Based on the diagnostic check, the formulated VEC model is appropriate for the data. The model can be used to forecast the quarterly GDP of the Philippines

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