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Research Article

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REGRESSION ANALYSIS OF THE ECONOMIC FACTORS OF THE GROSS DOMESTIC PRODUCT IN THE PHILIPPINES

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ABSTRACT

The researchers intends to formulate a mathematical model in estimating GDP of the Philippines, as well as identify some of its factors. GDP is considered as the dependent variable while there are seven independent variables namely Capital Formation, Total Trade, Interest Rate, Inflation Rate, Unemployment Rate, and Stock Exchange Index. This paper make use of the quarterly time series data of the eight variables from 1995 to 2016. Applying multiple linear regression, only Capital Formation, Total Trade, Interest Rate, Exchange Rate and Unemployment Rate are found to be significant predictors of GDP. Based on the modelformulated using normal estimation equation by means of matrices, the said factors can explain GDP by 93 percent, and there is no significant difference between the actual and predicted values obtained through the model according to the result of Paired T-test.

Keywords: Paired t-Test; GDP; Normal Estimation Equation; Mathematical Model; Multiple Linear Regression.

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1. INTRODUCTION

Economic growth of a country depends on the market value of all goods and services produced within the borders of the nation, commonly called as the Gross Domestic Product or GDP. GDP is considered as one of the principal indicators in determining the health of the economy [1].

During the mid-1990s in the Philippines, the national government was able to maintain the GDP of the country at a rate of 17.5 percent, even with a debt-to-GDP ratio of 48 percent in 1996. However, beginning 1997, many crisis hit the Philippines including the Asian Financial Crisis which caused tax effort to decline rapidly into 11.8 percent of GDP. According to the World Bank Philippine Office, the debt of the national government has become more than five times its revenue and, by 2004, the national government interest payments reached 5.1 percent of GDP [2]. Just after the 2004 elections that the GDP of the Philippines had started to show significant improvements in the country's fiscal position.

The National Economic and Development Authority (NEDA) reported that the Philippines has enjoyed satisfactory performance in terms of GDP with an average full-year growth of 5.8 percent in 2015 being able to provide ample growth in jobs and corporate profits. And for developing countries like the Philippines, a huge leap from the average growth rate helps in expediting the improvement and stabilization of the economy [3].

As an indicator of economic growth, GDP must be monitored and analyzed cautiously. This research intends to formulate a mathematical model that can actually estimate the GDP of the Philippines. Also, the researchers desire to determine the significant factors that can influence the GDP among several economic variables. By means of a statistical analysis, this paper aims to predict the GDP of the Philippines.

1.1. Research Paradigm

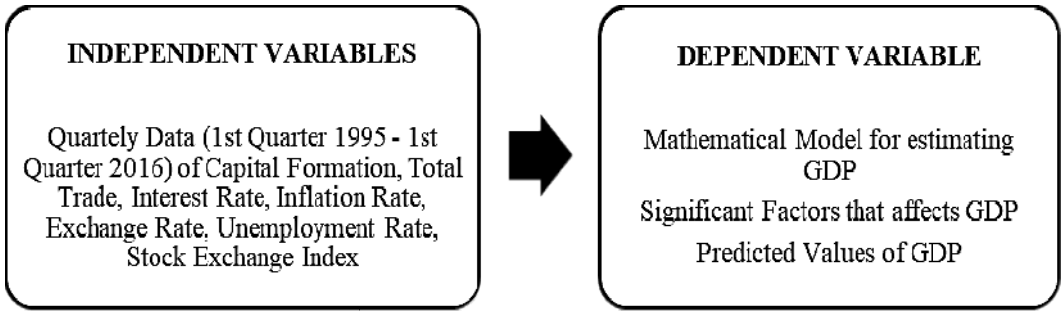


Fig.1. Research paradigm

The researchers followed a research paradigm which includes the independent and dependent variables. From the research paradigm, there are eight variables to be considered, arranged in a quarterly basis. A normal estimation equation by means of matrices, and a multiple linear regression are to be applied to the data, in order to come up with the expected output as indicated in the diagram.

1.2 Statement of the Problem

Specifically, this research aims to answer the following questions which leads to formulating the mathematical model for the GDP of the Philippines:

1. What is the behavior of the graph of each variables?
    a. Gross Domestic Product
    b. Capital Formation
    c. Total Trade
    d. Interest Rate
    e. Inflation Rate
    f. Exchange Rate
    g. Unemployment Rate
    h. Stock Exchange Index
2. Is there a significant relationship between the dependent and independent variables?
3. What are the significant factors that can actually predict the GDP?
4. Applying normal estimation equation using matrices, what will be the mathematical model for estimating GDP?
5. Is there a significant difference between the actual and predicted values obtained

using the formulated model for GDP?

1.3 Scope and Limitations

A total of 85 observations and eight variables are used in this research. Data are gathered and obtained from Bangko Sentral ng Pilipinas (BSP) and cover a total of 20 years starting from the first quarter of 1995 to the first quarter of 2016. GDP is considered as the dependent variable while there are seven independent variables namely Capital Formation, Total Trade, Interest Rate, Inflation Rate, Exchange Rate, Unemployment Rate, and Stock Exchange Index.

2. METHODOLOGY

2.1 Multiple Linear Regression

The multiple linear regression is used to study the relationship between a dependent variable and one or more independent variables. The generic form of the regression model is written as:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \ldots + \beta_k x_k + \varepsilon \quad (1)$$

where ŷ is the predicted value of the dependent variable, β_0 is the y intercept, x_1 to x_k are the explanatory variables, β_1 to β_k is the change in y for each one increment change in the explanatory variables, and ε is the disturbances [4].

2.2 Normal Estimation Equation

In constructing a model, a matrix notation can aid for the computations and manipulations. The whole sample of n observations can be expressed in the matrix notation:

$$y = x\beta + u \quad (2)$$

where y is the n-dimensional column vector, x is a $n(k+1)$ matrix, β is a $(k+1)$-dimensional column vector of parameters, and u is a n-dimensional column vector of error terms.

$$\begin{bmatrix} y_1 \\ y_2 \\ y_3 \\ \vdots \\ y_n \end{bmatrix} = \begin{bmatrix} 1 & x_1 & \cdots & x_{1k} \\ 1 & x_2 & \cdots & x_{2k} \\ 1 & x_3 & \cdots & x_{3k} \\ \vdots & \vdots & \ddots & \vdots \\ 1 & x_{n1} & \cdots & x_{nk} \end{bmatrix} \times \begin{bmatrix} \beta_0 \\ \beta_1 \\ \beta_2 \\ \vdots \\ \beta_k \end{bmatrix} + \begin{bmatrix} u_1 \\ u_2 \\ u_3 \\ \vdots \\ u_n \end{bmatrix} \quad (3)$$

Ordinary least squares (OLS) minimizes the squared distances between the observed and predicted variable y:

$$S(\beta) = \sum_{i=1}^{n} (y_i - x'_i\beta)^2 = (y - x\beta)'(y - x\beta) \rightarrow \min \beta \quad (4)$$

The resulting OLS estimator of β is written as:

$$\beta' = (x'x)^{-1}x'y \quad (5)$$

Its matrix nature is written in the form of

$$\begin{bmatrix} n & \sum_{i=1}^{n} x_{1i} & \cdots & \sum_{i=1}^{n} x_{2i} & \sum_{i=1}^{n} x_{ki} \\ \sum_{i=1}^{n} x_{1i} & \sum_{i=1}^{n} x_{1i}^2 & \cdots & \sum_{i=1}^{n} x_{1i}x_{2i} & \sum_{i=1}^{n} x_{1i}x_{ki} \\ \vdots & \vdots & \cdots & \vdots & \vdots \\ \sum_{i=1}^{n} x_{ki} & \sum_{i=1}^{n} x_{ki}x_{1i} & \cdots & \sum_{i=1}^{n} x_{ki}x_{2i} & \sum_{i=1}^{n} x_{ki}^2 \end{bmatrix} \begin{bmatrix} \beta_0 \\ \beta_1 \\ \vdots \\ \beta_k \end{bmatrix} = \begin{bmatrix} \sum_{i=1}^{n} y_i \\ \sum_{i=1}^{n} x_{1i}y_i \\ \vdots \\ \sum_{i=1}^{n} x_{ki}y_i \end{bmatrix} \quad (6)$$

This can be used to predict the dependent variable, and the error term called as residual [5].

2.3 Paired T-test

Paired sample t-test is a statistical technique that is used to compare two population means in the case of two samples that are correlated. Paired sample t-test is used in 'before-after' studies, or when the samples are the matched pairs. To calculate the parameter, the formula to be used is written as [6]:

$$t = \frac{\bar{y}}{\sqrt{s^2/n}} \quad (7)$$

where $\bar{y}$ is the mean difference between two samples, s^2 is the sample variance, n is the sample size and t is a paired sample t-test with $n-1$ degrees of freedom.

3. RESULTS AND DISCUSSION

3.1 Behavior of the graph

GDP, from the past 20 years, has shown an increasing trend with some fluctuations. From the lowest record of GDP on the first quarter of 1995, it hit an all-time high on the fourth quarter of 2015.

During the fourth quarter of 1999, low gross domestic capital formation was recorded due to low foreign direct investment (FDI), and inadequate public sector revenues according to the Joint Foreign Chambers (JFC) of the Philippines [7]. On the other hand, the highest capital formation was recorded on the year 2015.

The graph of total trade reveals an elevating trend having its lowest record during 1995, and highest during 2015. In 2015, growth were recorded in nine major imported commodity groups, most of which are classified as capital and consumer goods [8].

From the past two decades, interest rate reached its peak during the first quarter of 1998 with 19.01. It is this season when the countries affected by the 1997 Asian Financial Crisis tried to rebound from the recession. It then dives down as time elapses, and even reached its lowest of 0.12 percent on the fourth quarter of 2013.

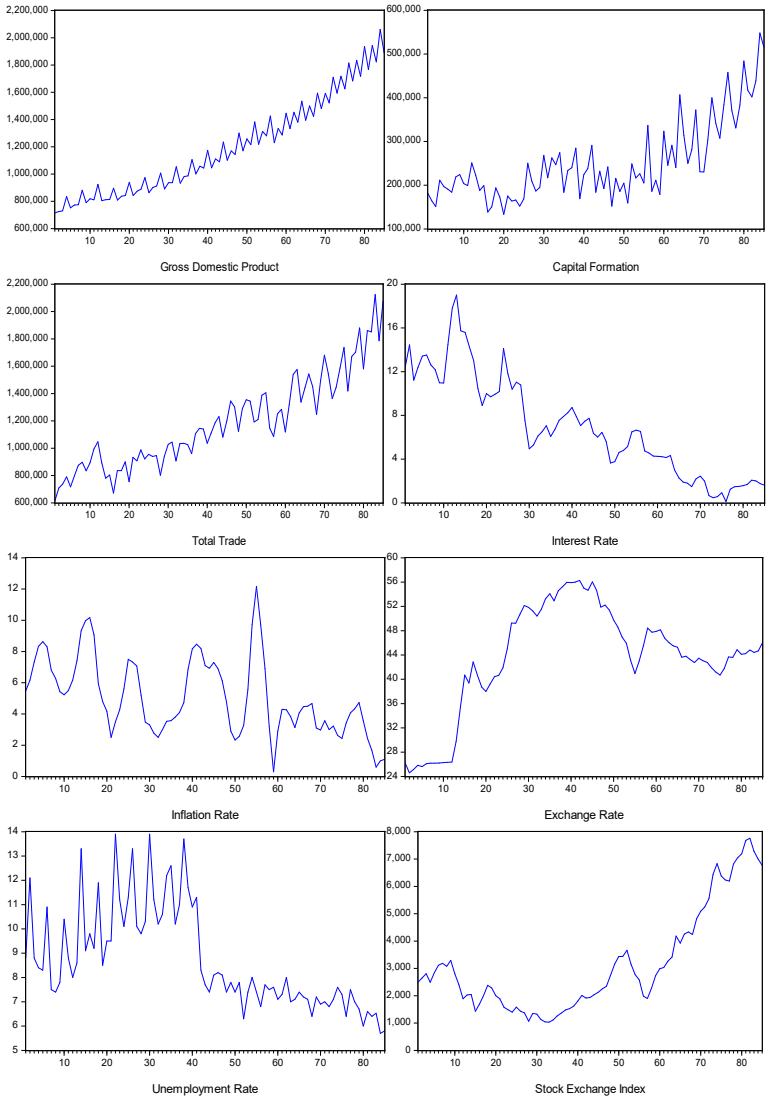


Fig.2. Graph of the variables (1995-2016)

As seen in the graph, the unemployment rate decreased by half on 2005. Rates were between the ranges of five percent to 15 percent earlier 200, then it declines to five to ten percent afterwards.

Philippine SEI marks 2003 as the lowest index due to the market's path being derailed by the US subprime crisis which set off a full-blown financial crisis, particularly in the US and Europe. It then rebounds afterwards and hits its peak on the second quarter of 2015 because of the structural current account surplus and ongoing fiscal policy discipline [11].

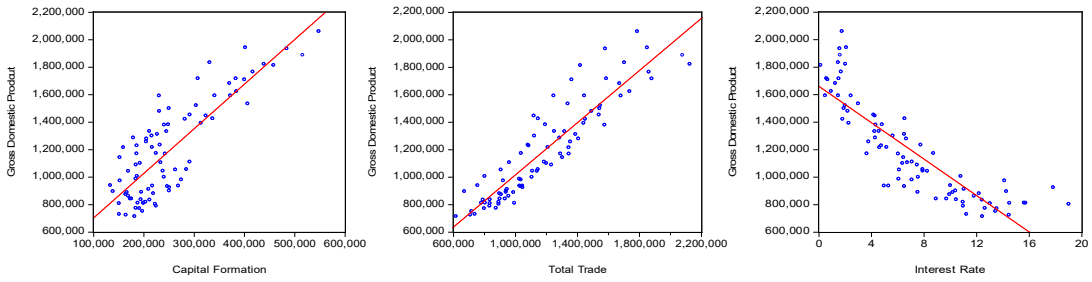
3.2 Significant Relationship

This study used the Pearson correlation coefficient in determining whether there exist a significant relationship between the dependent and independent variables.

Table 1. Correlation

	Pearson r	**p-value**
Capital Formation	0.835	0.000
Total Trade	0.914	0.000
Interest Rate	-0.861	0.000
Inflation Rate	-0.512	0.000
Exchange Rate	0.300	0.005
Unemployment Rate	-0.685	0.000
Stock Exchange Index	0.848	0.000

Table 1 reveals the correlation coefficient, as well as the p-value of the independent variables analyzed against GDP. The results indicate that all the variables have a significant relationship with GDP since their p-values is less than the level of significance of 0.01.



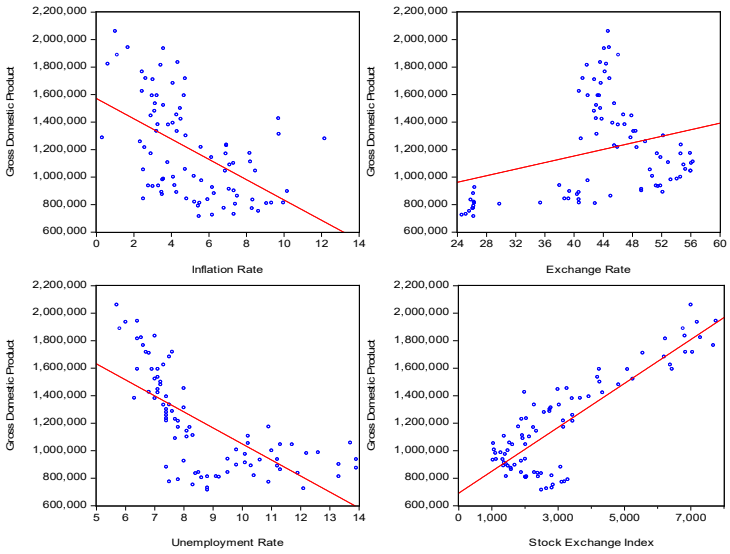


Fig.3. Scatterplot diagram

From the table, it can be seen that Capital Formation, Imports, Exports, and Stock Exchange Index have a strong positive linear relationship with GDP with their coefficients lying within the ranges of 0.7 to 0.9. This means that an increase in the said variables can also cause the GDP to elevate.

On the other hand, Interest Rate is exposed to have a negative yet strong linear relationship with GDP, as seen in the scatterplot diagrams of the variables. Same goes with the Inflation Rate and Unemployment Rate having an inverse relationship with GDP since their coefficients is shown to be negative, with a moderate linear relationship against the dependent variable. The downward regression line indicated in the scatterplots of the said variables means that they can cause the GDP to decline once their values rise. Among the variables, only Exchange Rate is discovered to have a weak linear relationship with GDP having a correlation coefficient of 0.300.

3.3 Significant Factors

In determining the predictors of GDP, the researchers conducted a multiplier linear regression. A logarithmic transformation has taken place to the dependent variable in order to satisfy all the required assumptions before conducting such a regression analysis. The level of significance used in order to determine the significant factors is considered to be 0.01. Those factors which has a p-value of less than the level of significance after applying a multiple linear regression is therefore concluded to be a significant predictor of GDP.

Table 2. Regression analysis

	p-value
Capital Formation	0.0002
Total Trade	0.0014
Interest Rate	0.0001
Inflation Rate	0.1025
Exchange Rate	0.0011
Unemployment Rate	0.0000
Stock Exchange Index	0.0493

As shown in Table 2, five out of seven independent variables was found out to be a predictor of GDP namely Capital Formation, Total Trade, Interest Rate, Exchange Rate, and Unemployment Rate having a p-value of 0.0002, 0.0014, 0.0001, 0.0011, and 0.0000 respectively. This means that any increase or decrease in the said variables can cause GDP either to inflate or deflate. The other two variables: Inflation Rate and Stock Exchange Index are found to be insignificant predictors due to their p-values being greater than 0.01 in the values of 0.1025 and 0.0493 correspondingly.

3.4 Mathematical Model

To be able to formulate the estimating model for GDP, the matrix theory was applied to this research for the mathematical computations and manipulations. The coefficients were obtained through the help of MATLAB. And the model can be written as:

$$\ln y = 13.52 + 0.000000611x_1 + 0.00000021x_2 - 0.0182x_3 + 0.0073x_4 + 0.0061x_5 - 0.0266x_6 + 0.0000261x_7$$

With a coefficient of determination of 0.937897, this model is actually good enough in predicting the dependent variable. But since two of the independent variables is found out to be insignificant predictors of GDP after performing a regression analysis, the researchers omit them from the equation. Thus, formulating a new estimation equation written in the form of:

$$\hat{y} = e^{(13.6475 + 0.000000728\ x_1 + 0.000000282\ x_2 - 0.0183\,x_3 + 0.004\,x_5 - 0.0296\,x_6)}$$

This mathematical model has a coefficient of determination of 0.932508. This indicates that the factors included in the model can explain GDP by almost 93 percent. From the model, it can be concluded that a one increase in Capital Formation, Total Trade and Exchange Rate

can cause GDP to increase by 0.000000728, 0.000000282, and 0.0040 respectively. Moreover, a one increase in Interest Rate and Unemployment Rate can deflate GDP by 0.0183 and 0.0296, correspondingly.

3.5 Predicted Values

Using the formulated mathematical model, the researchers are able to predict the values of the GDP. The researchers applied a Paired T-test to analyze and determine whether there exist a significant difference between the actual and predicted values of the dependent variable.

Table 3. Paired t-test

t-statistic	p-value
0.329419	0.7427

Based on the p-value of 0.7427, as shown in Table 3, which is greater than the level of significance of 0.01, the alternative hypothesis was then rejected. Therefore, it is concluded that there is no significant difference between the actual values of GDP and the predicted ones which are obtained through the formulated model.

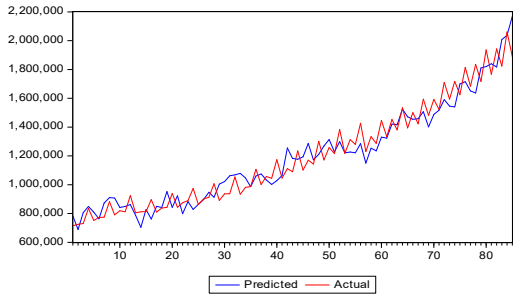


Fig.4. Graph of the actual and predicted values of GDP

Furthermore, the graph of the two values reveals that the values are closely related to each other indicating that they are closely identical to each other.

4. CONCLUSION

Economic growth is commonly measured using GDP, and in countries like Philippines, it is very essential to monitor such values in order to govern the nation and its citizens towards progress. In this study, the researchers are able to formulate a mathematical model in estimating GDP in the Philippines, as well as identify some of its factors. Applying a regression analysis, Capital Formation, Total Trade, Interest Rate, Exchange Rate and Unemployment Rate are found to be significant predictors of GDP. Based on the model

formulated using normal estimation equation by the aid of matrices, the said factors can explain GDP by 93 percent. While the predicted values obtained using the mathematical model is found to have no difference from the actual values, and is actually 74 percent close to the actual ones.

This study then recommends the government to take on account the said significant variables. Since unemployment rate and interest rate are found to be one, and it showed to have an inverse relationship with GDP, more job opportunities should be created for those unemployed citizens, and interests should be lowered as much as possible. Furthermore, with capital formation, total trade and exchange rate having a positive relationship with GDP, the administration should focus on investments which can create jobs, increase imports or exports, as well as remittances. A further study is also suggested in investigating the economic growth in the Philippines.

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