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Modeling the Philippines' Exchange Rate: A Regression Analysis

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Abstract:

This study aims to formulate a Mathematical model for the Exchange Rate in the Philippines. The following factors examined in this research are: interest rate (x_1), inflation rate(x_2), Labor Force Participation Rate (x_3) and Total Trade (x_4) as the independent variables affecting the Exchange Rate (y).The researchers analyzed data from the 1st quarter of 2010 up to the 4th quarter of 2014.the data were gathered from National Statistical Coordination Board (NSCB). This research used a Normal Estimation Equation using Matrices to create the model for Exchange Rate and used $\alpha = 0.01$. *Logarithm transformation was then used to transform the data particularly to the Dependent variable (y) to satisfy all the assumptions on Multiple Regression Analysis. MATLAB was used to formulate a mathematical model and were written as:*

$$\hat{y} = e^{1.499462 + 0.032157X_1 + 0.033037X_3}$$

This research revealed that only two independent variables are of significance to the dependent variables namely: interest rate (X_1) and

Labor force participation rate (X_3) therefore; it can predict the Exchange rate (y) in the Philippines. The regression analysis shows that 83.5% (coefficient of determination) of the independent variable can predict the Dependent Variable. With 89.5% of the result in Paired T-Test, the Predicted Values acquired from the model showed no significant difference from the Actual Values of Exchange Rate. This research will be helpful to our government since Exchange Rates are one of substantial components of a country's development and economic growth.

Key words: Logarithmic Transformations, MATLAB, Matrices, Multiple Linear Regression, Normal Estimation Equation, Exchange Rate.

1. Introduction

The Exchange Rate is one of the most substantial components of a country's relative level of economic health. Having a high exchange rate in one country can help in the economic growth. For this reason, Exchange Rates are among the most monitored, analyzed and governmentally manipulated economic measures.

Economist consider that having a poor manage exchange rate can be a disastrous for economic growth. If the exchange rate falls, this changes the relative prices of imports and exports. Exports will appear to become relatively cheaper in other currencies, and imports will appear to be more expensive. [1]

A strong exchange rate is often considered to be a sign of economic strength. It can become a symbol of national pride. Often politicians are worried if they see a 'weakening' in the exchange rate. They will point to a strong exchange rate as a symbol of economic success.[2]

There are a wide variety of factors which influence the Exchange Rate such as interest rates, inflation, and the state of politics and the economy in each country. [3]

In this paper, researchers considered four (4) explanatory variables which mostly affect the exchange rate in our country. These are interest rate(X_1), Inflation rate(X_2),labor force participation rate(X_3), and total trade (X_4). The effects of these factors will be further explained and revealed the relationship in the exchange rate in the Review of Related Literature.

This research will be helpful in estimating the Exchange Rate. Having an accurate estimated exchange rate will become an advantage to our economy as well as in our country's development.

2. Objective of the Study

The main objective of this study is to formulate a mathematical model of the Exchange Rate using matrices. The researchers also want to determine the factors that influencing the Exchange Rate using Multiple Linear Regression. The researcher will examine the relationship of the Dependent variable Exchange Rate and the independent variables that used in this research such as interest rate (X_1), inflation rate (X_2), labor force participation rate (X_3), and total trade (X_4). This research will be helpful to the government to have an accurate Exchange Rate.

3. Statement of the Problem

This study is conducted to formulate a mathematical model to through regression analysis to estimate the future Exchange Rate. This research also wants to answer the following questions:

1. What is the behavior of the graph of the following variables?
    - 1.1. Interest rate (X_1)
    - 1.2. Inflation rate (X_2)
    - 1.3. Labor force participation rate (X_3)

1.4. Total trade (X_4)

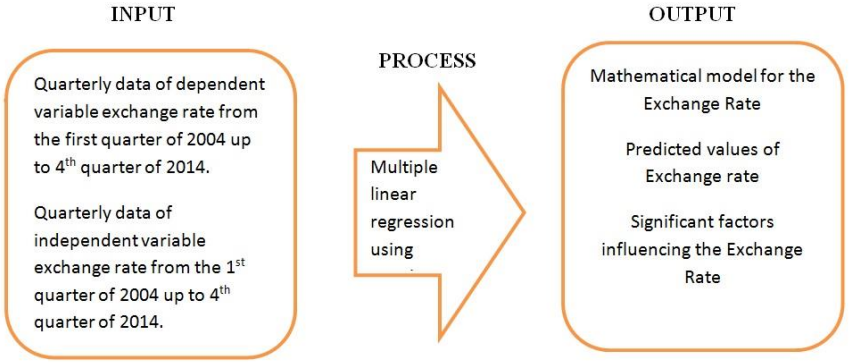
2. Is there a significant relationship between the dependent variable to the independent variable?

3. What could be the mathematical model that can be formulated through regression analysis using matrices that could estimate the future Exchange rate of our country?

4. What are the significant factors that can actually predict the Exchange rate of our country?

5. Is there a significant difference between the predicted values to the actual values?

Figure 1: Research Paradigm



In figure 1, the independent variables and dependent variables of the Exchange rate from the 1st quarter of 2004 up to 4th quarter of 2014 are used to make a model to estimate the Future exchange rate of the Philippines. Significant relationships among variables were obtained after some data transformation. Multiple linear regression using matrices was then used after satisfying the assumptions to make model that will estimate the Philippine exchange rate in the future.

4. Scope and Limitation

The scope of this research is from the first quarter of2004 up to the last quarter of 2014. The data were gathered from the National Statistical Coordination Board.

The Researchers formulate regression models using matrices by considering the following independent variables such as interest rate(X_1), inflation rate(X_2), labor force participation rate(X_3), and total trade (X_4).

5. Review of Related Literature

This section will reveal the relationship of the following independent variables to the dependent variable through the use of previous writings and studies of the people that are pioneer in this field.

According to the book of OECD Economic Surveys: South Africa (2010) "Lower inflation rates would also translate into lower nominal *interest rates*, discouraging the carry trade. To respond to the pressures on the nominal *exchange rate* once inflation is under control, one option would be to include the exchange rate".[4]

According to Akampa (2010) "when the international exchange rate falls, the local currency in relation to world currencies appreciates, imports become cheaper, exports become expensive thus leading to more imports and less exports. On the other hand, when the international exchange rate rises, the local currency in relation to world currencies depreciates, imports become more expensive, exports become cheaper and the country exports more and imports less. From this deduction, we note that foreign exchange rate movements affect international prices both negatively and positively leading to either a decline or boost in trade".[5]

According to the book of the great Recession and Developing Countries: Economic Impact and growth (2010) "A higher exchange rate can help reduce inflation pressures and rebalance the economy. The case for a larger role of interest rates in monetary policy is strong. Also, if policy makers remain concerned about interest rates-sensitive capital flows, more exchange rate flexibility would help". [6]

Aubuin and Ruta (2011) stated that "since the highest performing firms are the largest exporters, the prices of tradable goods are relatively insensitive to exchange rate movements". [7]

According to Cuecuech and Pederzini (2012) "Remittance-receiving households may reduce their labor supply because they have now a source of funds other than their own labor income, hence they can consume more leisure. Remittance inflows and the associated higher consumption levels can lead to price increases and exchange rate movements and further undo some of the positive economic effects." [8]

Carrasco and Ferreiro (2013) analyzed inflation expectations in Mexico and applied unit root, normality and co-integration tests. The results they obtained rejected the null hypothesis of normality for inflation expectations over studied period. They demonstrated a persistent relationship between the exchange rate and the interest rate. They also observed that inflation expectations influence long term dynamics. [9]

According to Liliana Bunescu (2014)"the impact of external debt on exchange rate variation in Romania The exchange rate is one of the most important macroeconomic variables in the emerging and transition countries. It affects inflation, exports, imports and economic activity. Exchange rates have long been thought to have an important impact on the export and import of goods and services, and, thus, exchange rates are expected to influence the price of those products that are traded". [10]

According to Manalo, Perera and Rees (2014) "Our results confirm that the mining, manufacturing, labor force, personal services and other business services industries are particularly sensitive to exchange rate movements, while social services output is somewhat less affected. Although exchange rate shocks can have a large effect on economic activity, these shocks explain only a small proportion of the volatility of Australian macroeconomic variables. Instead, most exchange

rate movements, at least over the medium- and long-run, are a response to more fundamental economic changes, and the resulting movements in the real exchange rate are a stabilizing influence on the economy." [11]

According to the research of Afshan and Batul (2014) "An increase in the exchange rate will lead to cost push on imported items than inflation arise in country. High inflation in an economy will lead to higher interest rate. High interest rate will lead to slow down in investment. In this study Autoregressive Distribution Lag (ARDL) model verify the effect of import, export; rate of inflation and interest rate on exchange rate have been found to be significant and insignificant. On primary analysis the variables are tested through ADF unit root test, Autoregressive distributed Lag estimates are determined , long run coefficient using the ARDL approach are calculated ,indicating negative insignificant only by rate of inflation in Pakistan while indicating positive insignificant only by interest rate and rate of inflation in India. Moreover import, export and interest rate are significant variables in case of Pakistan while import and export both variables are significant variables in India." [12]

In the Philippines, Ben d. Kritz (2010) said that for an import-dependent country like the Philippines, it is difficult to overstate the impact of currency exchange rates. There is almost no part of the economy that is not affected by them in some way, particularly because of the country's import profile; the Philippines imports virtually all of its fuel, most of its transportation equipment, and a very large proportion of the raw materials and intermediate goods needed for manufacturing. [13]

6. Research Methodology

The methods that were used by the researchers are Jarque-Bera for the normality test. Wald test for linearity, Variance

Inflation Factor for multicollinearity and Breusch-Pagan test for heteroscedasticity.

6.1 Statistical tool

Eviews is a brand of software used for calculating, studying, and showing economic data such as statistics and sales forecasts.[14]It is the statistical tool used by the researchers to satisfy all the assumptions in multiple Regressions and to determine the significant factors affecting the Exchange Rate.

MATLAB® is the high-level language and interactive environment used by millions of engineers and scientists worldwide. It lets you explore and visualize ideas and collaborate across disciplines including signal and image processing, communications, control systems, and computational finance [15]. It is the tool used to construct the mathematical model of the Philippines' Exchange Rate.

6.2 Statistical treatment

Since there were more than one Independent variables used in this research, Multiple Regression using matrices was used to construct the mathematical model that would estimate the Exchange Rate in the Philippines.

All calculations were obtained using normal equation. MATLAB was used for matrix calculation and Eviews for the Regression models.

6.2.1 Multiple Linear Regression

Multiple linear regression attempts to model the relationship between two or more explanatory variables and a response variable by fitting a linear equation to observed data. Every value of the independent variable x is associated with a value of the dependent variable y. [16]

The multiple linear regression equation is as follows:

$$\hat{Y}=\beta_0+\beta_1X_1+\beta_2X_2+\ldots\ldots\beta_pX_p$$

where $\hat{Y}$ is the predicted or expected value of the dependent variable, X_1 through X_p are p distinct independent or predictor variables, b_0 is the value of Y when all of the independent variables (X_1 through X_p) are equal to zero, and b_1 through b_p are the estimated regression coefficients. [17]

6.2.2 Stepwise Multiple Linear Regression

It is a step-by-step iterative construction of a regression model that involves automatic selection of independent variables. Stepwise regression can be achieved either by trying out one independent variable at a time and including it in the regression model if it is statistically significant, or by including all potential independent variables in the model and eliminating those that are not statistically significant, or by a combination of both methods. [18]

6.2.3 Paired T-test

A statistical examination of two population means. A two-sample t-test examines whether two samples are different and is commonly used when the variances of two normal distributions are unknown and when an experiment uses a small sample size. And it is calculated as:

$$t = \frac{\bar{d}}{\sqrt{s^2/n}}$$

Where $\bar{d}$ is the mean difference, s^2 is the sample variance, n is the sample size and t is a Student t quintiles with n-1 degrees of freedom.[19]

6.2.4. Normal Estimation Equation using Matrices

In fitting a multiple linear regression model, knowledge of matrix theory can facilitate the mathematical manipulations considerably. Using matrix notation, the equation can be written as:

$$y = X\beta + c$$

$$y = \begin{bmatrix} y_0 \\ y_1 \\ \vdots \\ y_k \end{bmatrix}, \quad X = \begin{bmatrix} 1\, x_{11} x_{21} \cdots x_{k1} \\ 1\, x_{12} x_{22} \cdots x_{k2} \\ \vdots\ \vdots\ \vdots \cdots \vdots \\ 1\, x_{xn} x_{2n} \cdots x_{kn} \end{bmatrix}, \quad \beta = \begin{bmatrix} \beta_0 \\ \beta_1 \\ \vdots \\ \beta_k \end{bmatrix}, \quad \epsilon = \begin{bmatrix} \epsilon_1 \\ \epsilon_2 \\ \vdots \\ \epsilon_n \end{bmatrix}$$

Then the least squares method for estimation of βinvolves finding for b for which $SSE = (y - Xb)'(y - Xb)$ is minimized. This minimization process involves solving for **b** in the equation $\frac{\partial}{\partial b}(SSE) = \mathbf{0}$. The result reduces to the solution of $b$in $(X'X)b = X\acute{y}$. By examining the nature of the X matrix, apart from the initial element, the ith row represents the x-values that give rise to the response y_i. The matrix is written as:

$$A = X'X = \begin{bmatrix} n & \sum_{i=1}^{n} x_{1i} & \cdots & \sum_{i=1}^{n} x_{2i} & \sum_{i=1}^{n} x_{ki} \\ \sum_{i=1}^{n} x_{1i} & \sum_{i=1}^{n} x_{1i}^2 & \cdots & \sum_{i=1}^{n} x_{1i}x_{2i} & \sum_{i=1}^{n} x_{1i}x_{ki} \\ \vdots & \vdots & \cdots & \vdots & \vdots \\ \sum_{i=1}^{n} x_{ki} & \sum_{i=1}^{n} x_{ki}x_{1i} & \cdots & \sum_{i=1}^{n} x_{ki}x_{2i} & \sum_{i=1}^{n} x_{ki}^2 \end{bmatrix}; g = X'y = \begin{bmatrix} g_0 \\ g_1 \\ \vdots \\ g_k \end{bmatrix} = \begin{bmatrix} \sum_{i=1}^{n} y_1 \\ \sum_{i=1}^{n} x_{1i}y_i \\ \vdots \\ \sum_{i=1}^{n} x_{ki}y_i \end{bmatrix}$$

Which allows the normal equations to be put in the matrix from $Ab = g$. [20]

7. Results and Discussion

This section will explain the behavior of the graph of the following independent variables and the dependent variables within the span of ten (10) years from the first quarter of 2010 up to the fourth quarter of 2014.

7.1. Behavior of the graph of the variables

7.1.1. Exchange rate (y)

Within the span of 10 years, the exchange rate (See Appendix G: Graph 2) in our countrydisplays an upward trend with some fluctuations because of imports became more expensive and higher domestic demand. Exchange Rate exhibits a downward trend reaching an all-time high of 6.45% in the 1st Quarter of 2008 and a record low of negative 8.85% in the 3rd Quarter of 2007.but early 2008Philippines experienced a favorable investor sentiment, which, in turn, is due to the economy's strong macroeconomic performance including sustained overseas Filipino remittances, net inflows of foreign portfolio investments and steady export earnings.

7.1.2. Interest Rate

Within the span of 10 years, interest rate (See Appendix G: Graph 3) reveals a fluctuating and decreasing pattern having its maximum and minimum increase of 9.65% and -17.58% respectively both on the 1st Quarter of year 2006 and 2012 correspondingly. In 2006, interest rate eased due to reflecting decelerating inflation, improving fiscal performance, and ample liquidity in the financial system.[21] On the quarter analysis of the Interest Rate of the Philippines, it can be seen that on the 1st Quarter, interest rate escalate to 9.65% during 2006 but dropped off of about -17.58% on 2012. During the 2nd Quarter, it showed a high growth of 8.17% on the year 2004 but dive down on 2006 with 10.57% decreases. For the 3rd Quarter, it revealed a positive growth of 8.45% on 2004 while a negative growth on 2011 of -9.25%. On the last quarter, its greatest point is during 2012 with 7.25% increase while its lowest point is on 2004 of -16.20%.

7.1.3. Inflation Rate

Inflation rate (See Appendix G: Graph 4) showed a depreciating trend with some changes. For every 1st Quarter, the highest growth is during 2008 with a double – digit increase of 37.23% declining to -18.52% on 2013. It on 2nd Quarter that it ascends to 33.81% on the year 2004 but deteriorate to negative 39.13% during 2009. A decrease of -29.49% was recorded during the 3rd Quarter of 2008 but immediately ascent to 47.73% on 2009 of the same quarter. By examining the quarterly increase, it is concluded that inflation rate grow the highest during the 3rd Quarter of 2009 having an increase of 47.73% due to higher food prices. However, it records the highest decrease on 2011 of negative 61.54% because of cost of housing and utilities and transport declined further and prices of food and non-alcoholic beverages slowed.

7.1.4. Labor force participation rate

Labor Force Participation Rate in Philippines (See Appendix G: Graph 5) averaged 65.90 percent from 1990 until 2014, reaching an all-time high of 94.70 percent in the fourth quarter of 1993 and a record low of 63.20 percent in the fourth quarter of 2007 [22] because the population gets bigger and inadequate education also, labor force participation rate was 36.10 in 2011. Its highest value over the past 21 years was 41.40 in 2001, while its lowest value was 33.90 in 2008.[23]

7.1.5. Total Trade

In past ten year's total trade (See Appendix G: Graph 6) shows an increasing trend with some fluctuations. Trade in services with the Philippines (exports and imports) totaled $6.2 billion in 2012. Services exports were $2.5 billion; Services imports were $3.7 billion. The U.S. services trade deficit with the Philippines was $1.2 billion in 2012.[24]

7.2. Significant relationships of the Independent variables to the Dependent variable.

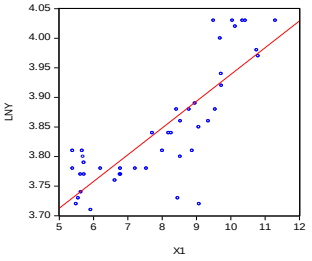
This research used the Pearson's coefficient of determination to determine the relationship of independent variables and dependent variables.

Table 7.2.1

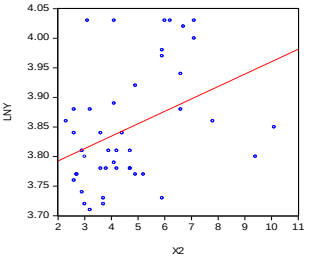
	Interest rate (x_1)	Inflation rate (x_2)	Labor Force participation rate (x_3)	Total trade (x_4)
Exchange Rate (y)	0.821	0.390	0.686	-0.725
p-value	0.005	0.000	0.000	0.000

As show in the table above, among of all independent variables interest rate and labor force participation rate shows a moderate positive correlation while total trade shows a negative correlation and inflation rate shows a moderate positive correlation. From the scatterplot, it shows that all independent variables are all linear to the dependent variable. Furthermore, the table above supports that the variables are all linear.

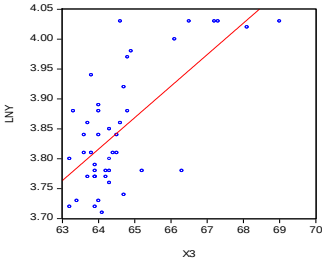
Exchange Rate to Interest rate



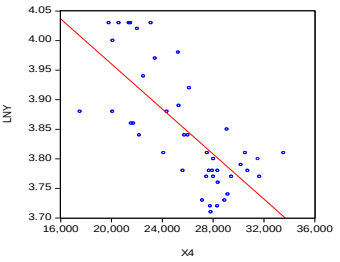
Exchange Rate to Inflation rate



Exchange Rate to labor force participation rate



Exchange rate to total trade



Significant linear relationships of all Independent Variables namely: interest rate (x_1), inflation rate (x_2) labor force participation rate (x_3) and total trade (x_4) to the dependent variable Exchange rate (y) are show in the scatter plots above provided that the p–value is less than α which is 0.01. A logarithm transformation was then used to satisfy all the assumptions in the Multiple Regression specifically to the dependent variable.

8. Mathematical Model formulated using Matrices through Normal Estimation Equation

Since this research used more one variable, matrix theory is used to conduct mathematical calculations in fitting Multiple Regression.

The least squares estimating equations $(X'X)\ b = X'y$

$$\begin{bmatrix} 44 & 351.846 & 204.5537 & 2842.7 & 1139359 \\ 351.846 & 2953.905 & 1707.445 & 22768.91 & 8885794 \\ 204.5537 & 1707.445 & 1096.776 & 13224.48 & 5219832 \\ 2842.7 & 22768.91 & 13224.48 & 183729.6 & 735162 \\ 1139359 & 8885794 & 521983 & 735162 & 30100000000 \end{bmatrix} \begin{bmatrix} \beta_0 \\ \beta_1 \\ \beta_2 \\ \beta_3 \\ \beta_4 \end{bmatrix} = \begin{bmatrix} 2074.604 \\ 16898.07 \\ 9793.074 \\ 134222.9 \\ 53149425 \end{bmatrix}$$

and then, using the relation $b = (X'X)^{-1}X'y$, the estimated regression coefficients are obtained as:

$\beta_0 = -73.60752$ β_1= 1.553079 ß$_2$ = 0.105150 ß$_3$=1.704047 ß$_4$ = - 0.0000866

The researchers use MATLAB to obtain the coefficient. Therefore the Exchange Rate can be computed using the regression equation:

$$ln\hat{y} = -73.60752 + 1.553079x1 + 0.0105150x2 + 1.704047x3 - 0.0000866x4$$

The model can estimate the Exchange rate in the Philippines with 83.5% coefficient of determination and has a p-value of 0.0000. However, two of the Independent Variables are not significant to Dependent Variable which is Inflation Rate (x_2) and total trade (x_4) as seen on the Pearson's coefficient correlation. It is concluded that the inflation rate and total

trade are not significantly affecting the Exchange Rate. To estimate the exchange rate accurately, the insignificant variables are not included and a new model is formulated.

Using the least square estimation:

$$\begin{bmatrix} 44 & 351.846 & 204.5537 & 2842.7 & 1139359 \\ 351.846 & 2953.905 & 1707.445 & 22768.91 & 8885794 \\ 2842.7 & 22768.91 & 13224.48 & 183729.6 & 735162 \end{bmatrix} \begin{bmatrix} \beta_0 \\ \beta_1 \\ \beta_3 \end{bmatrix} = \begin{bmatrix} 169.3 \\ 328857189.7 \\ 10944 \end{bmatrix}$$

and the relation $b = (X'X)^{-1}X'y$, the new estimated regression coefficients are acquired as:

β_0=1.499462 β_1=0.032157 β_2=0.002063 β_3=0.033037 β_4= -0.00000202

Exchange Rate can be predicted more accurately using the model:

$$\hat{y} = e^{1.499462 + 0.0.32157X_1 + 0.33037X_3}$$

Estimation of the Exchange Rate using this new model has a coefficient of determination $R^2 = 0.845$ and is significant at 1% level.

8.1. Significant factors that can influence Real Gross Domestic Product (y)

This research used Eviews in conducting stepwise Multiple regression to know the significant factors affecting the independent variable (y). The result of regression analysis(See Appendix E: Table 6) shows that interest rate (x_1) has a p-value of 0.0000, inflation rate with 0.6258 while labor force participation rate and total trade has a p-value of 0.0000 and 0.4781 respectively. The results of four independent variables shows that only interest rate and labor force participation rate are significant factors affecting the Exchange Rate, which are interest rate (x_1)and labor force participation rate (x_3) with 1% level of significance.

8.2. Significant difference of the predicted value from the actual value

The researchers used the paired t test (Appendix 3: Table C) to know the significant difference of the actual value form the predicted value. The result shows that the predicted value has89.5% mathematically identical from the actual value. Therefore there is no significant difference between the actual value form the predicted value. Therefore, the significant factors affect the Exchange Rate.

9. Summary of findings, conclusions and recommendations

9.1. Behavior of the graph of the variable

Exchange rate and total trade shows an increasing trend while inflation rate and interest rate and labor force participation rate show some fluctuations within the period of time. It greatly shows that interest rate and labor force participation rate are significant factors of exchange rate.

9.2. Significant relationship of the independent variables to the dependent variables

The researchers used the paired t-test to examine the significant difference between the actual value and the predicted value of Exchange Rate.

9.3 Mathematical model

The formulated mathematical model using Matrices through Normal Estimation Equation which estimates the Exchange Rate is written as:

$$\hat{y}=e^{1.373258+0.036251X_1+0.033821X_3}$$

9.4. Significant factors affecting the Exchange Rate (y)

After running Multiple Regression, Interest rate (x_1) and Labor force participation rate (x_1) have found to have a significant

relationship to Exchange Rate (y) with 1% level of significance. Therefore; it shows that two independent variables qualified to become the predictors of Exchange Rate (y).

9.5 Difference between the predicted and the actual values of Exchange Rate

Since the result in paired T-test is 0.895 therefore it shows that there is no significant difference between the actual value and predicted value of the Exchange Rate.

Conclusion

After having Logarithm transformation and satisfying all the assumptions in Multiple Regression, the acquired Mathematical model shows that the two independent variables are significant to Exchange Rate (y) namely: Interest rate (x_1) and labor force participation rate (x_3). The model also signifies that it can actually predict the Exchange Rate for the Predicted Values obtained from the model and is mathematically identical from the Actual Values of Exchange Rate.

Recommendation

Since this research revealed that only the Interest Rate and Labor force participation Rate are significantly related to the exchange Rate, The researchers suggest adding more predictors and data series to predict the Exchange rate more accurately. This could be helpful to our government since Exchange Rates are one of substantial components of a country's development and economic growth.

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APPENDICES

Table 1: Original Data

Year	Quarters	Exchange Rate (y)	Interest Rate(x1)	Inflation Rate(x2)	Labor Force Participation Rate(x3)	Total Trade(x4)
2004	Q1	56.3570	10.044	3.1	67.3	19803
2004	Q2	56.1810	9.497	4.1	69.0	20586
2004	Q3	56.3360	10.342	6.2	67.2	21378
2004	Q4	56.3570	11.297	7.1	66.5	21505
2005	Q1	56.1810	9.687	7.1	66.1	20106
2005	Q2	55.9190	10.126	6.7	68.1	22030
2005	Q3	56.0550	10.424	6.0	64.6	23100
2005	Q4	53.0670	10.794	5.9	64.8	23437
2006	Q1	51.2840	9.717	6.6	63.8	22505
2006	Q2	53.5870	10.755	5.9	64.9	25258
2006	Q3	50.3870	9.727	4.9	64.7	26119
2006	Q4	49.1320	8.954	4.1	64.0	25303
2007	Q1	48.2620	8.786	2.6	64.8	24362
2007	Q2	46.3290	8.259	2.6	64.5	25745
2007	Q3	45.0630	8.872	2.9	63.6	27531
2007	Q4	41.4010	9.079	3.7	63.2	28343
2008	Q1	41.8680	8.455	5.9	63.4	27153
2008	Q2	44.7560	8.524	9.4	63.2	28034
2008	Q3	46.9170	9.063	10.1	64.3	29095
2008	Q4	47.4850	9.343	7.8	63.7	21541
2009	Q1	48.4190	9.543	6.6	63.3	17525
2009	Q2	48.3080	8.418	3.2	64.0	20080
2009	Q3	47.5920	8.534	2.3	64.6	21737
2009	Q4	46.3560	8.186	4.4	64.0	22186
2010	Q1	45.2200	8.004	3.9	64.5	24104
2010	Q2	46.3100	7.710	3.6	63.6	26016
2010	Q3	43.8960	7.537	3.8	63.9	28366
2010	Q4	43.8850	7.215	3.6	64.2	27944
2011	Q1	43.4320	6.792	4.9	63.7	28016
2011	Q2	43.4940	6.770	5.2	64.2	27482
2011	Q3	43.6360	6.780	4.7	64.3	27692
2011	Q4	43.9280	6.206	4.2	66.3	25611
2012	Q1	43.0000	6.621	2.6	64.3	28387
2012	Q2	42.2830	5.631	2.9	64.7	29158
2012	Q3	41.8800	5.553	3.7	64.0	28906
2012	Q4	41.1920	5.491	3.0	63.9	27777
2013	Q1	40.9380	5.920	3.2	64.1	27823
2013	Q2	43.3070	5.617	2.7	63.9	29443
2013	Q3	43.3090	5.721	2.7	63.9	31648
2013	Q4	44.4140	5.718	4.1	63.9	30193
2014	Q1	44.9960	5.667	4.2	63.8	30536
2014	Q2	43.7800	5.391	4.7	65.2	30727
2014	Q3	44.9660	5.386	4.7	64.4	33547
2014	Q4	44.6170	5.690	3.0	64.3	31523

Appendix 2

Table 2: Transformed Data

Year	quarter	Exchange Rate (LNY)	Interest Rate (x_1)	Inflation Rate (x_2)	Labor force participation rate (x_3)	Total trade (x_4)
2004	Q1	4.03	10.044	3.1	67.3	19803
2004	Q2	4.03	9.497	4.1	69.0	20586
2004	Q3	4.03	10.342	6.2	67.2	21378
2004	Q4	4.03	11.297	7.1	66.5	21505
2005	Q1	4.00	9.687	7.1	66.1	20106
2005	Q2	4.02	10.126	6.7	68.1	22030
2005	Q3	4.03	10.424	6.0	64.6	23100
2005	Q4	3.97	10.794	5.9	64.8	23437
2006	Q1	3.94	9.717	6.6	63.8	22505
2006	Q2	3.98	10.755	5.9	64.9	25258
2006	Q3	3.92	9.727	4.9	64.7	26119
2006	Q4	3.89	8.954	4.1	64.0	25303
2007	Q1	3.88	8.786	2.6	64.8	24362
2007	Q2	3.84	8.259	2.6	64.5	25745
2007	Q3	3.81	8.872	2.9	63.6	27531
2007	Q4	3.72	9.079	3.7	63.2	28343
2008	Q1	3.73	8.455	5.9	63.4	27153
2008	Q2	3.80	8.524	9.4	63.2	28034
2008	Q3	3.85	9.063	10.1	64.3	29095
2008	Q4	3.86	9.343	7.8	63.7	21541
2009	Q1	3.88	9.543	6.6	63.3	17525
2009	Q2	3.88	8.418	3.2	64.0	20080
2009	Q3	3.86	8.534	2.3	64.6	21737
2009	Q4	3.84	8.186	4.4	64.0	22186
2010	Q1	3.81	8.004	3.9	64.5	24104
2010	Q2	3.84	7.710	3.6	63.6	26016
2010	Q3	3.78	7.537	3.8	63.9	28366
2010	Q4	3.78	7.215	3.6	64.2	27944
2011	Q1	3.77	6.792	4.9	63.7	28016
2011	Q2	3.77	6.770	5.2	64.2	27482
2011	Q3	3.78	6.780	4.7	64.3	27692
2011	Q4	3.78	6.206	4.2	66.3	25611
2012	Q1	3.76	6.621	2.6	64.3	28387
2012	Q2	3.74	5.631	2.9	64.7	29158
2012	Q3	3.73	5.553	3.7	64.0	28906
2012	Q4	3.72	5.491	3.0	63.9	27777
2013	Q1	3.71	5.920	3.2	64.1	27823
2013	Q2	3.77	5.617	2.7	63.9	29443
2013	Q3	3.77	5.721	2.7	63.9	31648
2013	Q4	3.79	5.718	4.1	63.9	30193
2014	Q1	3.81	5.667	4.2	63.8	30536
2014	Q2	3.78	5.391	4.7	65.2	30727

2014	Q3	3.81	5.386	4.7	64.4	33547
2014	Q4	3.80	5.690	3.0	64.3	31523

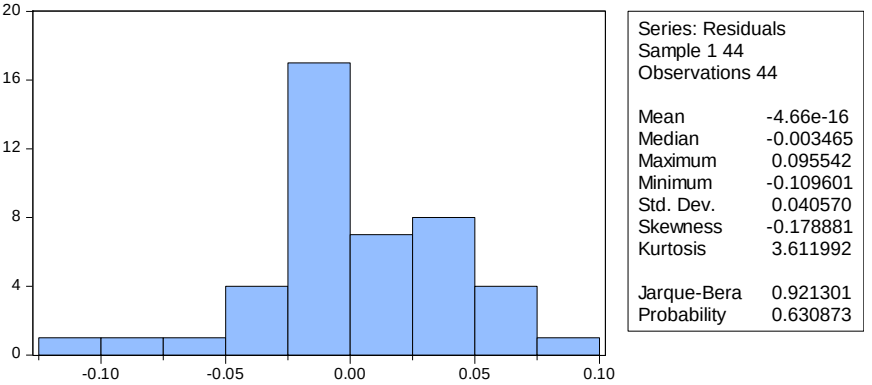
Appendix 3: Table 3

Actual Value	Predicted Value
4.0317	4.01279
4.0286	4.05258
4.0313	4.02270
4.0301	4.03171
4.0036	3.96963
4.0239	4.04557
4.0263	3.93466
3.9716	3.95228
3.9374	3.88788
3.9813	3.95064
3.9197	3.90703
3.8945	3.85880
3.8766	3.87867
3.8358	3.84895
3.8081	3.83560
3.7233	3.82902
3.7345	3.82303
3.8012	3.82457
3.8484	3.87792
3.8604	3.87720
3.8799	3.87580
3.8776	3.85029
3.8627	3.86862
3.8364	3.84123
3.8115	3.84703
3.8354	3.80302
3.7818	3.80312
3.7816	3.80322
3.7712	3.77574
3.7726	3.79347
3.7759	3.79558
3.7826	3.84702
3.7612	3.78438
3.7444	3.76509
3.7348	3.74154
3.7182	3.73697
3.7121	3.75774
3.7683	3.73693
3.7684	3.73576

3.7936	3.74176
3.8066	3.73631
3.7792	3.77488
3.8059	3.74227
3.7981	3.74903

Appendix B

Graph 1



H_0: The data are not normally distributed.

H_a: The data are normally distributed.

Rejection rule: If P-value is greater than 0.01, then reject the null hypothesis.

Conclusion: Since the p-value is 0.630873 which is greater than α, then failed to reject the null hypothesis. Therefore it shows that the residuals are normally distributed.

Appendix C

Table 4

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.402662	Prob. F(4,39)	0.2511
Obs*R-squared	5.533848	Prob. Chi-Square(4)	0.2368
Scaled explained SS	5.677967	Prob. Chi-Square(4)	0.2245

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 04/30/15 Time: 13:43
Sample: 1 44
Included observations: 44

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.011159	0.023982	0.465318	0.6443
X1	0.000612	0.000389	1.571053	0.1242
X2	-9.95E-05	0.000254	-0.391066	0.6979
X3	-0.000341	0.000342	-0.997432	0.3247
X4	3.11E-07	1.71E-07	1.815777	0.0771

R-squared	0.125769	Mean dependent var	0.001609
Adjusted R-squared	0.036105	S.D. dependent var	0.002630
S.E. of regression	0.002582	Akaike info criterion	-8.974012
Sum squared resid	0.000260	Schwarz criterion	-8.771263
Log likelihood	202.4283	Hannan-Quinn criter.	-8.898823
F-statistic	1.402662	Durbin-Watson stat	1.848411
Prob(F-statistic)	0.251097		

H_o: There are no significant independent variables to the dependent variables.
H_a: At least one independent variable is significant to the dependent variable.
Rejection Rule: To reject the null hypothesis, the p-value should be less than α which is equal to 0.001.
Conclusion: Since the result of Breusch Pagan-Godfrey test for heteroscedasticity is 0.251097 then, **fail to reject** null hypothesis. Hence, there exists homoscedasticity.

Appendices D: Table 5

Testing for multicollinearity

Variance Inflation Factors
Date: 04/30/15 Time: 13:44
Sample: 1 44
Included observations: 44

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
C	0.156588	3796.586	NA
X1	4.13E-05	67.14867	**3.190873**
X2	1.76E-05	10.64997	**1.416314**
X3	3.18E-05	3221.140	**1.258583**
X4	7.98E-12	132.4723	**2.714493**

General Rule: To satisfy the assumptions of Multiple Regression; the Variance Inflation Factor (VIF) should be in the range of 1 to 10.
Conclusion: Since the test for multicollinearity shows that the value of VIF ranges from 1 to 10, and then it shows that there is no multicollinearity among the independent variables.

Appendices E: Table 6

Dependent Variable: LNY
Method: Least Squares
Date: 05/05/15 Time: 18:14
Sample: 1 44
Included observations: 44

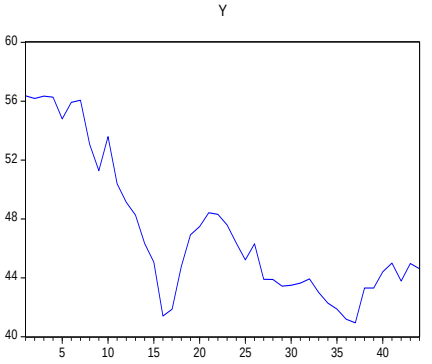
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.499462	0.395712	3.789273	0.0005
X1	0.032157	0.006423	5.006611	0.0000
X2	0.002063	0.004197	0.491607	0.6258
X3	0.033037	0.005641	5.856929	0.0000
X4	-2.02E-06	2.83E-06	-0.716286	0.4781

R-squared	0.835350	Mean dependent var	3.848182
Adjusted R-squared	0.818463	S.D. dependent var	0.099983
S.E. of regression	0.042600	Akaike info criterion	-3.367282
Sum squared resid	0.070776	Schwarz criterion	-3.164533
Log likelihood	79.08021	Hannan-Quinn criter.	-3.292093
F-statistic	49.46656	Durbin-Watson stat	1.599819
Prob(F-statistic)	0.000000		

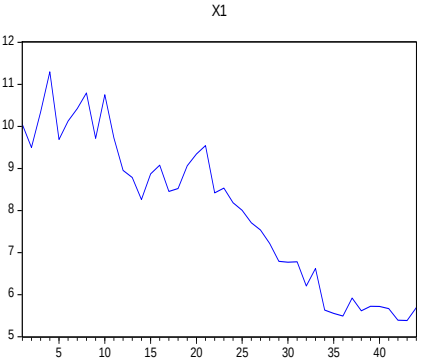
H_o: There are no independent variables that are significant to dependent variable.
H_a: At least one independent variable that is significant to dependent variable.
Rejection Rule: To reject null hypothesis, the p-value should be less than $\propto$ which is 0.01.
Conclusion: Since the p-value is 0.000000 then, **reject** null hypothesis for the Wald Test. Therefore, at least one of the independent variable is significant to the dependent variable.

Appendix F

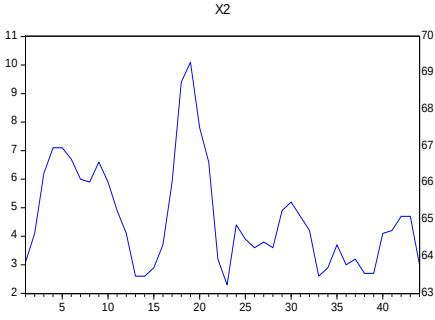
Graph 2: exchange rate



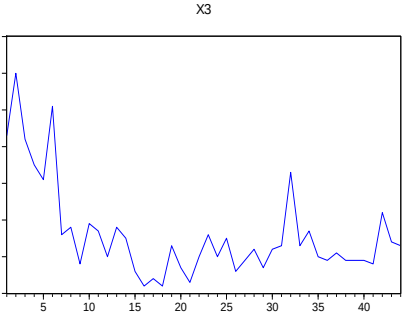
Graph 3: Interest rate



Graph 4: Inflation Rate



Graph 5: Labor Force Participation Rate



Graph 6: Total Trade