Granger-causal relationship between real exchange rate and economic growth: Malaysia as a case study

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Abstract:

This report tries to examine the Granger-causality relationship between real exchange rate and economic growth using Malaysia as a case study. Using standard time series techniques, we found that the real exchange rate is an exogenous variable to net import and GDP. The results based on the generalized variance decompositions (VDC) tend to indicate that the GDP is a lagging endogenous variable and could not impact the exchange rate. On the other hand, the change in real exchange rate can influence the economic growth. It is also found that the government policy in putting foreign exchange reserve can influence exchange rate and economic growth. In addition, since the exchange rate leads economic growth, the policies which claim to be able to influence the exchange rate, such as monetary policy, would benefit the policy makers from further studies.

Keywords: Real exchange rate, economic growth, VECM, VDC, Malaysia

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Introduction

Countries are often proud of a strong exchange rate because it is usually considered to reflect economic strength. Politicians tend to worry about a 'weakening' of their exchange rate as it is more common to see them making their case for economic success showing how strong the exchange rate is during their term at office.

For the policy makers, important question arises; what impact does a strong or weak exchange rate have on the economy? Does the stage of the country's economic cycle influence the currency to be stronger or weaker? Or in econometrics terms, which variable leads and which variable is the follower?

It is critical for the study of world economics and for policy decisions to observe the causality between the exchange rate and economic growth. In theory the effect of Real Exchange Rate (REXR) on economic growth, trade and structural change is interdependent (Welfens, 2008). However, the causality between the two is still debatable.

According to Ito et al (1999), the economic growth has impact on changing the exchange rate. These can be explained in two ways. First, when the country can produce high export product, the net export is positive resulting in increasing in GDP. The demand of the country goods raise the exchange rate. Second, when the GDP increases and people have more income, demand for import product will be higher and the currency will depreciate.

On the other hand, the changing in exchange rate is also explained to be a leader to GDP. For example, changing in the country's monetary policy can also influence the real exchange rate and has impact on the GDP. The changing in interest rate can affect real exchange rate due to capital investment flow. The capital from aboard will flow into the country which has higher rate of return resulting in appreciation in value of the currency.

When the real exchange rate is high, foreign goods become cheaper than domestic goods. In the opposite ways, if real exchange rate is depreciated, foreign goods are more expensive compared to domestic goods. The changes in the real Exchange rate affects the net exports of the country, trade balance, thereby having an influence on the GDP which measures economic growth (Mankiw, 2013).

The issue of real exchange rate and economic growth is also empirically controversial. Japan and Germany saw their currency appreciation in the post-war period after their economic growth became sustainable. This shows that in the long run, a strong currency (exchange rate appreciation) becomes evident in countries experiencing low inflation, high international competitiveness with a strong economic performance.

On the contrary, China and developing countries tends to devalue their exchange rate in order to boost economic growth (Chen, 2012). This is because the demand for exports increases due to the exports becoming cheaper for foreign countries, which would in turn lead to more production and hence boost the country's economic growth.

To understand the importance of REXR and its implication on economic growth, how nations use REXR when developing their economic policies should also be looked into. In order to show if there truly exists a relationship between the REXR and the Economic growth, this paper first looks at the underlying theories of REXR and how it is connected with economic growth theoretically. Then the literature will give insight into the various studies done with empirical results showing the nature of the relationship between REXR and economic growth. Next the paper would attempt to justify the nature of the causality between REXR and Economic growth by employing econometric models.

The paper is an attempt to help policy makers by giving more insight into the causal relationship between growth and real exchange rate employing data for the Malaysian economy for the period covering17 years starting from 1999. The result of this study should able to indicate the effectiveness of monetary policy. If the exchange rate is a leading factor to GDP, manipulating the rate by changing in interest rate through monetary policy can play important role to the country economy. The study employs econometric methods of time series technique, in particular, co-integration, error correction modeling and variance decomposition, in order to find empirical evidence on the causality of real exchange rate and GDP.

Literature Review

Theoretical underpinnings

The theoretical relationships that real exchange rate and economic growth have to one another can be anlaysed by going through factors that influence exchange rates which are also relevant to economic growth or Gross Domestic Product (GDP).

To understand Real Exchange Rates, we need to first know what Nominal Exchange Rate is. Mankiw (2013) defines Nominal Exchange rate as the relative price of the currencies of two countries, which is commonly known as Exchange Rate. For instance, for a Malaysian girl who wants to buy a dress priced a hundred U. S. Dollars (USD), she has to buy USD giving her currency, Malaysian Ringgit (RM), if the exchange rate is 1USD=RM4, then she needs to pay RM400 to buy USD100.

If the girl has to pay RM3 instead of RM4 to buy USD1, would be an increase in the exchange rate in terms of Malaysian Exchange in terms of USD. This is termed "appreciation" or it can be said that Ringgits grew stronger. And if the girl has to pay RM5 instead of RM4 to get 1USD, it means the Ringgits have grown weaker in value and it is termed as "depreciation".

The Real Exchange Rate tells us the rate at which the same good would be exchanged for the same good in another country. It is calculated using the nominal exchange rate between two countries and the price levels in the two countries. If the real exchange rate is high, foreign goods become cheaper than domestic goods. When Real Exchange rate is low, foreign goods are more expensive compared to domestic goods.

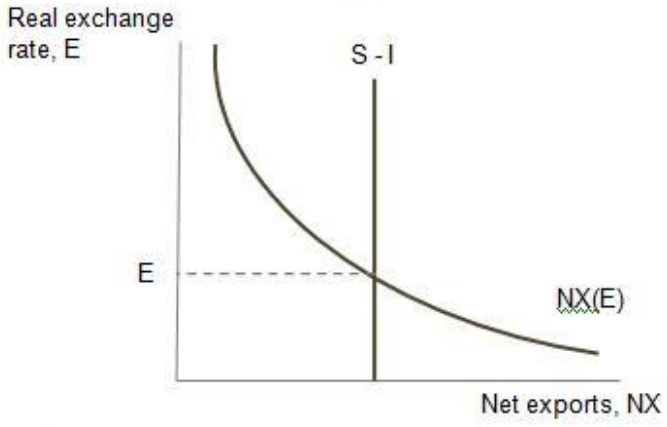
REXR = (Nominal exchange rate x Price of the foreign basket) / (Price of the domestic basket)

Real Exchange Rate and Trade Balance

The changes in the Real Exchange rate affects the net exports of the country; the trade balance. Net Exports is the value of Exports minus the value of Imports. Figure 1 shows the relationship between the REXR and Net Exports is negative. This means with low REXR, Net Exports are greater and when REXR is high Net Exports is low. The REXR is determined by the intersection between the Net Exports curve and the vertical line representing Saving (S) minus Investment (I).

E is the Real Exchange rate where, the quantity of local currency supplied for net foreign investment equals the quantity of local currency demanded for the net export of goods and services.

Figure 1: Real Exchange Rate and Trade Balance



(Source: Mankiw, 2013)

In the case of low REXR when domestic goods are relatively cheap, domestic residents will demand less for expensive imports. And there will be increased demand for local goods from foreigners too. Both these actions results in increasing the quantity of Net Exports. The opposite happens when REXR is high, domestic good become expensive to locals and foreigners which makes locals demand for imports more, making the quantity of Net Exports negative.

The trade balance (Net Exports) equal the net capital outflow. This is equal to Savings(S), which is fixed by the consumption function and fiscal policy) *minus* Investment (I), fixed by the investment function and the world interest rate (Mankiw,2013).

The Net Exports is one of the components that determines a country's GDP. When a country exports goods, foreigners demanding these exports bring in money into the economy which in turn increases the GDP of the country. If the country imports goods, the country has to pay out to the foreign countries, making money leave the country, hence decreasing the nation's GDP.

$$GDP = C + I + G + (X-M)$$

where C is consumption, I is investment, G is government expenditure and (X-M) is net exports (exports-imports). Hence if there is a change in any of the components it would affect the GDP. Net Exports is positively related to GDP, which means that if the Net exports increase, GDP will increase and if the Net Exports becomes low it would lead to a decrease in the nations GDP.

Welfens (2008) shows how Real Exchange Rate affects economic growth, trade and structural change interdependently. In the medium term, trade volume and current account position is affected by the REXR through the imports and exports mix. The structure of output linked to the sectoral development is also affected, moreover. In the medium term and the long run, National Income ad per capita will be directly and indirectly affected by the REXR, which would in turn affect structural change and trade. In an open economy, if there are capital inflows, the increase in foreign direct investments would increase investments leading to productivity potential and productivity growth, hence economic growth.

There is a relationship between Real Exchange rate and GDP through Net Exports. While Net Exports are a function of the real exchange rate, it is also a component of the GDP. As this is only based on theory there is a need to find any empirical studies have been conducted to find if the theory stands in the case of Real Exchange Rate and GDP having a relationship. The next part of the paper looks across the literature to find studies done on this relationship between Economic Growth (measured by GDP) and Real Exchange Rate (Mankiw, 2013).

Real Exchange Rate and Monetary Policy

A country's monetary policy is often designed considering the impact it would have on the country's REXR together with the likely effects on inflation and the level of economic activity. For the Central Banks these decisions always have to incorporate a number of objectives they are trying to achieve simultaneously. In most developing countries, Central banks would want to ensure that the movement of the nominal exchange rate holds the REXR in a stable competitive level for a longer term by systematic intervention in the exchange rate markets. But if the Central Bank focuses on the REXR by manipulating the exchange rate market rather than focusing on the nominal exchange rate, the desired effects of the policies on controlling the inflation would not be met and it would fail to control the money supply (Frenkel and Taylor, 2006).

However, if monetary authorities have a developmental objective, the authorities can avoid this dilemma in practice. According to Frenkel and Taylor (2006), these are some of the considerations that should be incorporated when developing a monetary policy of the nation with regard to its relationship with REXR. Demoting inflation control from the hierarchy of policy objectives as many developing countries have low to medium inflation rates. Also, if the country (under a "speculative" exchange rate regime is likely to experience inflationary nominal depreciation, then targeting REXR will help the economy to lower that possibility. The changes in the Aggregate Demand should however be taken into account when formulating policies based on REXR. Using a mix of temporary capital inflow or outflow controls might help governments more in regulating the unstable and unpredictable money demand and the authorities need to be stable yet flexible tacking these. It is common to see even that interest rate targets are not achieved using the single target policies. If governments in the developing and transition countries focus on keeping REXR stable and competitive then it can achieve their main policy objective of economic development.

Empirical Literature

The relationship between real exchange rate (REXR) and economic growth have been studied across literature with empirical evidence from different countries. Later studies have focused on coming up with policy implications for governments to influence economic growth via overvaluation or undervaluation of the exchange rate of a country.

A fundamental index of REXR overvaluations which is based on a structural macroeconomic model has been used by Razin and Collins (1999) for developed and developing countries. The study done on the pooled sample was for a period of 16 to 18 year periods since 1975 on 93 countries. The study found that the REXR overvaluation index had a negative relationship with economic growth. The effect of asymmetry was also found from the study showing that the negative relationship between overvaluation and economic growth was stronger than the effect undervaluation had positively on the economic growth. On another study with a similar index of REXR for a panel of 60 developed and developing countries over 1965 till 2003, it was also found that the negative effect of overvaluation on economic growth is more than the positive effect of undervaluation on a country's growth (Aguirre & Calderon, 2005). Even on studies evaluating effects of REXR on PPP- based index rather than the fundamentals- based index, the negative relationship between overvaluation and growth continues to hold. One such study by Prasad et al. (2007) shows that capital inflows makes an economy grow and that capital inflows are positively related with a PPP- based index of REXR overvaluation. However, the results do not apply to the developed countries where the results show that the sign is opposite. They state that the reason for this might be due to the scenario in develop countries where the capital inflows appreciate domestic currency which in turn hurts the economic growth as a result of low incentives to invest in manufacturing industries. Another study on a panel of 58 developing countries from 1960 to 1999, by a PPP-based index of REXR overvaluation finds a negative relationship between GDP per capita growth (Gala, 2008).

Literature shows that the studies done using econometric models utilizing control variable, where results are robust, there are also studies which does not estimate an equilibrium REXR. Hausmann et al. (2005) observes that between 1960 till 2000, there were 83 episodes of acceleration of sustained growth in developing and developed countries which were right after periods of REXR depreciations. Berg et al. (2008) find that REXR overvaluation affects adversely the duration of growth spells while investigate the factors that make growth episodes sustainable in both developing and developed countries in a similar study. Foreign exchange reserve accumulation and REXR are also positively correlated with GDP per capita growth Polterovich & Popov (2002). Levy-Yeyati and Sturzenegger (2009) did a study done only on developing countries also confirms the relationship that REXR is positively correlated (in independent regression analyses) with GDP

growth. Both studies give the implication that foreign exchange reserves maintained by the central banks are used to keep the REXR undervalued in order to stimulate growth.

Tests for asymmetries between developing and developed nations were carried out by Rodrik (2008) basing the study on a PPP-based index of REXR undervaluation using fixed-effects model for a panel of 184 countries between 1960 and 2004. With developing countries, it was found that there was the positive relationship between REXR undervaluation and economic growth. The main finding of study was this relationship is stronger and more significant in developing countries compared to developed countries.

Ito, et. al. (1999) examined that the positive relationship between economic growth and real appreciation using Balassa-Samuelson hypothesis and found in Japan it was stronger compared to other "tigers,'' or newly industrialized economies (NIEs). In Chile it was a bit stronger than Mexico and Papua New Guinea (PNG), where negative growth (compared to the United States) and depreciation (negative appreciation) were correlated positively. United States, Australia, Canada, New Zealand, and the Philippines experienced growth rates similar to each other with little depreciation or appreciation. In Indonesia, Thailand, and Malaysia, although the extent of depreciation was slight, they experienced high growth with real depreciation.

Data and Methodology

Data collection and transformation

In order to construct this study, we used quarterly macroeconomic data spanning over 17 years starting from the beginning of 1999, after the Asian financial crisis. The total of 68 observations were obtained. The selected variables consist of real exchange rate (REXR), real GDP (RGDP) is computed based on nominal GDP and inflation (using CPI index), Net export (NEXP) which is the difference between net export minus net import, and the country foreign reserve fund (REV). All data are collected from the data stream.

Research methodology, results and interpretation

This study employs a time series technique, in particular, cointegration, error correction modeling and variance decomposition, in order to find empirical evidence of the nature of relations between

real exchange rate and economic growth. This technique is favored over the traditional regression technique for the accompanying reasons.

Firstly, it has been proven that most financial and economic variables are non-stationary, not constant in mean and variance over time. This implies performing normal regression on the variables will render the outcomes deceiving, as measurable tests like t-test and F-test are not valid when dealing with non-stationary variables. Performing the normal regression on the variables with different form can solve the statistical issue, however, it will also remove the theoretical element out of the variables. Thus, the test is only statistic not the economic theory.

Secondly, in traditional regression assume the theoretical relationship between the variables, the endogeneity and exogeneity of variables are also assumed. However, since there are conflicting in theories in relationship between economic growth and real exchange rate, letting the data determine its relationship tends to be more precise. The time series technique is suite with this purpose because it can prove relationship through cointegration. Furthermore, the endogeneity and exogeneity of the variables will also be determined from the data.

Testing stationarity of variables

First, the unit root test for stationary and non-stationary characteristic of variables was conducted in order to proceed with the co-integration test in the next steps. A variable is stationary when its mean, variance and covariance are constant over time. If the entire variable is stationary, it fulfills the assumption of simple OLS regression. However, most of the economic variables are proven to be non-stationary which makes the OLS test such as R-square and t-test are not valid. In time series technique is applicable with I (1) variables, the variable with non-stationary in original level form but stationary in first differenced form. Therefore, the Augmented Dickey-Fuller (ADF) test was conducted on each variable, both level and different form, to test the characteristic of our variables. After the test, we found that ***all of our observed variables, including: real exchange rate (REXR), real GDP (RGDP), net export (NEXP), and foreign exchange reserve (REV) are I (1) variables.*** The table below summarizes the results of the ADF test. See Appendix 2 for details.

Table 1: Results of the ADF stationary test[1]

	ADF		
Variable	Test Statistic	Critical Value	Implication
Variable in level form			
LREXR	-1.2042	-3.4824	non-stationary
LRGDP	-1.7410	-3.4824	non-stationary
LNEXP	-1.9733	-3.4824	non-stationary
LREV	-1.2443	-3.4824	non-stationary
Variable in differenced form			
DREXR	-4.1891	-3.4836	Stationary
DRGDP	-6.1547	-3.4836	Stationary
DNEXP	-9.8438	-3.4836	Stationary
DREV	-5.2121	-3.4836	Stationary

Note that in determining which test statistic to compare with the 95% critical value for the ADF statistic, we have selected the ADF regression order based on the highest computed value for Akaike Information Criterion (AIC) and Schwarz Bayesian Criterion (SBC). In some instances, AIC and SBC give different orders and in that case, we compared both of them. However, none of our variables than AIC and SBC provides different result in terms of stationary test.

[1] The null hypothesis for the ADF test is that the variable is non-stationary. In all cases of the variable in level form, the test statistic in absolute term is lower than the absolute of critical value. Therefore, we cannot reject the null. Conversely, in all cases of the variable in differenced form, the absolute of test statistic is higher than the absolute of critical value. Thus we can reject the null and conclude that the variable is stationary (in its differenced form)

Determination of lag order using VAR model

Before proceeding with test of co-integration, we determined the order of the vector auto regression (VAR), which is the number of lags that the variables are depending on past values. Based on highest computed values for AIC and SBC, after stipulating an arbitrary relatively high VAR order of 6, the results show that AIC recommends order of 2 whereas SBC suggests zero lag (see Appendix 3 for details)

Table 2: Lag order identification

	Choice Criteria	
	AIC	SBC
Optimal order	2	0

Since AIC and SBC suggest in different lag order, the serial correlation for each variable has been considered in order to choose the accurate lag order. The result of the serial correlation test shows that there are two out of four variables which exist the serial correlation as shown in below table (See Appendix 4 for details). Thus, it should be more proper to select the higher lag order in order to avoid the effects of serial correlation. Therefore, we selected the lag order of 2.

Table 3: the serial correlation test

Variable	**p-value**	**Implication (at 5%)**
DREXR	0.845	no serial correlation
DRGDP	0.000	There is serial correlation
DNEXP	0.016	There is serial correlation
DREV	0.586	no serial correlation

Testing Cointegration

The cointegration test is conducted in order to prove the theoretical relationship between variables. If there is cointegration, it means that the variables are moving together in long run. The methods which normally used to test cointegration are Engle-Granger (E-G) and Johansen's cointegration tests. The Johansen cointegration tests is more advance than E-G in this testing because it not only test whether there is cointegration or not but also can suggest number of cointegration of the variables.

The E-G test indicates that there is the cointegration between the variables. Furthermore, the Johansen's cointegration test is conducted to our variables. The test result in both (1) base on maximal eigenvalue of the stochastic matrix and (2) based on trace of the stochastic matrix indicate that there is one cointegrating vector of our variables as show in following table (See Appendix 5 for details).

Table 4: Maximal Eigenvalue and Trace test results[2]

Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix				
Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	34.7716	31.7900	29.1300
r<= 1	r = 2	19.0984	25.4200	23.1000

Cointegration LR Test Based on Trace of the Stochastic Matrix				
Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	64.9058	63.0000	59.1600
r<= 1	r = 2	30.1342	42.3400	39.3400

[2] Maximal Eigenvalue and Trace, the test statistic for null of r = 0 is greater than the 95%, therefore, we reject the null that r=0. However, the test statistic is less than critical value for null of r = 1, thus, we cannot reject the null that r=1.

Long Run Structural Modeling (LRSM)

Next, the LRSM test is conducted in order to test the statistical findings with theoretical expectations. The REXR which is the interested variable is normalized with exactly identifying restriction test by giving its estimated coefficient equal to one. The obtained results are shown in the following table (See Appendix 6.1 for details).

Table 5: Exact Identification results

Variable	**Estimated Coefficient**	**Standard Error**	**t-ratio**
LREXR	1.0000	none	**-**
LRGDP	3.4345	2.0034	1.7143
LNEXP	0.061898	0.11269	0.5493
LREV	-0.52895	0.29247	-1.8086

The t-ratio of LRGDP and LREV are close and over than two respectively which show the level of significant of the variable. The t-ratio of LNEXP identified that the variable is insignificant. In order to test for the statistic significant of each level we further conducted over-identifying restrictions for each variable and measure the Chi-Sq. p-value more than 5% where we cannot reject the null hypothesis that the restriction is correct. The result we found is shown as following table (See Appendix 6.2 for details).

Table 6: Over Identification results[3]

Variable	Panel A	Panel B	Panel C
LREXR	1.0000 (NONE)	1.0000 (NONE)	1.0000 (NONE)
LRGDP	4.0893 (2.2767)	2.7330 (2.1812)	0.00 (NONE)
LNEXP	0.00 (NONE)	0.00 (NONE)	0.00 (NONE)
LREV	-0.57680 (0.35254)	0.00 (NONE)	0.00 (NONE)
Trend	-.042901 (0.023310)	-.040645 (0.032278)	.0015101 (0.0029625)
P-value	0.627	0.001	0.000

From the result, only panel given estimate coefficient of net export (LNEXP) insignificant (equal to zero) gives the p-value more than 5% which we cannot reject the null hypothesis that the given restriction is correct. This indicate that the real exchange rate of the country is not significantly be explained by its net export. However, although the over identifying test indicates that LNEXP is not significant (estimated coefficient equal to zero), we decided to keep it in our remaining test due to the fact that it was proved from the cointegration test that it has cointegrating vector together with other variables. Furthermore, we still not able to conclude that which variables are leaders and which are followers, thus, it is better to keep this variable remain for the next steps.

[3] The null hypothesis of over identification test is that the given restriction is correctly identified

Vector Error Correction Model (VECM)

From LRSM, we test the significant and also found the estimated coefficient of variables. However, we still have no idea whether which variables are exogenous (independent) and which are endogenous (dependent), especially between the two interested variables, REXR and RGDP.

By knowing which variable is exogenous and endogenous, the policy maker can better forecast and implement policy focus on the exogenous variable (if possible) which can affect the endogenous which is the follower variable.

Therefore, in order to test this causality, the VECM is conducted.

By examining the error correction term, et-1, for each variable, and checking whether it is significant, we found that there are three exogenous variables, LREXR, LNEXP, and LREV while LRGDP is the only endogenous variable as shown in the table below. (see Appendix 7)

Table 7: ECM(-1) results[4]

Variable	**ECM(-1) p-value**	**Implication**
LREXR	0.449	Variable is exogenous
LRGDP	0.000	Variable is endogenous
LNEXP	0.809	Variable is exogenous
LREV	0.958	Variable is exogenous

The implication of this result can provide us the causality between real exchange rate and real economic growth. The result shows that GDP is lagging variable and could not create impact to the exchange rate. On the other hand, the changing in real exchange rate can influence the economic growth.

[4] the null hypothesis of VECM test is that the variable is exogenous. If the p-value is less than 5%, we reject the null and accept that the variable is endogenous

However, VECM test cannot provide the level of exogenous and endogenous between variables. Therefore, in order to find out whether which variables is the most exogenous, we conduct the variance decomposition test which will be elaborated in the next session.

Variance Decomposition (VDC)

From VECM test, we found that only LRGDP is endogenous variable and others are exogenous. At this stage we performed VDC test which can indicate the degree of exogeneity of each variable. VDC decomposes the variance of forecast error of each variable into proportions attributable to shocks from each variable in the system, including itself. The most exogenous variable is the variable whose variation is explained mostly by its own past variations.

There are two types of VDC test, orthogonalized and generalized approach. The generalized approach is more preferred compared to the orthogonalized approach. This is because the orthogonalized approach depends on the particular ordering of the variables in the VAR and has assumption that when a particular variable is shocked, all other variables in the system are switched off. The generalized does not depend on ordering of the variables in the VAR, therefore, it less bias toward the variable order.

In order to avoid the limitation of the orthogonalized approach, we conduct the test base on the generalized approach. The result of the test in 1 year, 2 years, 3 years and 5 years are shown in the following tables. (see Appendix 8 for details).

Table 8-11: VDC test base on Generalized Approaches

Forecast at Horizon = 1 year (4 Quarters)

GENERALIZED APPROACH

Horizon	Variable	LREXR	LRGDP	LNEXP	LREV
1Year	LREXR	90.40%	0.78%	5.05%	3.76%
	LRGDP	3.70%	42.67%	3.54%	50.09%
	LNEXP	22.82%	10.54%	65.30%	1.35%
	LREV	0.44%	0.70%	2.37%	96.49%
	Exogeneity	90.40%	42.67%	65.30%	96.49%
	Ranking	2	4	3	1

Forecast at Horizon = 2 years (8 Quarters)

GENERALIZED APPROACH

Horizon	Variable	LREXR	LRGDP	LNEXP	LREV
2 Years	LREXR	89.98%	0.82%	4.71%	4.50%
	LRGDP	5.84%	29.56%	2.62%	61.98%
	LNEXP	26.25%	7.94%	64.62%	1.19%
	LREV	0.27%	0.52%	2.37%	96.84%
	Exogeneity	89.98%	29.56%	64.62%	96.84%
	Ranking	2	4	3	1

Forecast at Horizon = 3 years (12 Quarters)

GENERALIZED APPROACH

Horizon	Variable	LREXR	LRGDP	LNEXP	LREV
3 Years	LREXR	89.84%	0.84%	4.57%	4.75%
	LRGDP	6.89%	22.53%	2.15%	68.43%
	LNEXP	27.64%	6.87%	64.34%	1.15%
	LREV	0.22%	0.46%	2.37%	96.95%
	Exogeneity	89.84%	22.53%	64.34%	96.95%
	Ranking	2	4	3	1

Forecast at Horizon = 5 years (20 Quarters)

GENERALIZED APPROACH

Horizon	Variable	LREXR	LRGDP	LNEXP	LREV
5 Years	LREXR	89.72%	0.86%	4.46%	4.96%
	LRGDP	7.93%	15.43%	1.67%	74.97%
	LNEXP	28.86%	5.94%	64.08%	1.12%
	LREV	0.17%	0.42%	2.37%	97.04%
	Exogeneity	89.72%	15.43%	64.08%	97.04%
	Ranking	2	4	3	1

From the result, we found that the REV is the most exogenous followed by REXR and NEXP respectively. The GDP is the least exogenous variable which is according to the VECM test which indicates that the GDP is the only endogenous variable in the group.

Since VDC determine the level of exogenous from degree of variation which is explained by its own past variations, therefore, it is not surprise that REV is the most exogenous because the level of reserve is normally determined independently from the government policy. However, the test indicates that the level of reserve can influence in changing of other variables such as exchange rate, net export and economic growth. Lastly, based on our focusing topic, it has proved that, in case of Malaysia, the real exchange rate is the leader and has influences to the growth of economic.

Impulse Response Functions (IRF)

IRF essentially is a graphical display of dynamic response path of a variable owing to a one-period standard deviation shock to other variables. The figures below show the response of variables in VAR system when more exogenous variable is shocked.

Figure 1: IRF when shocked LREV

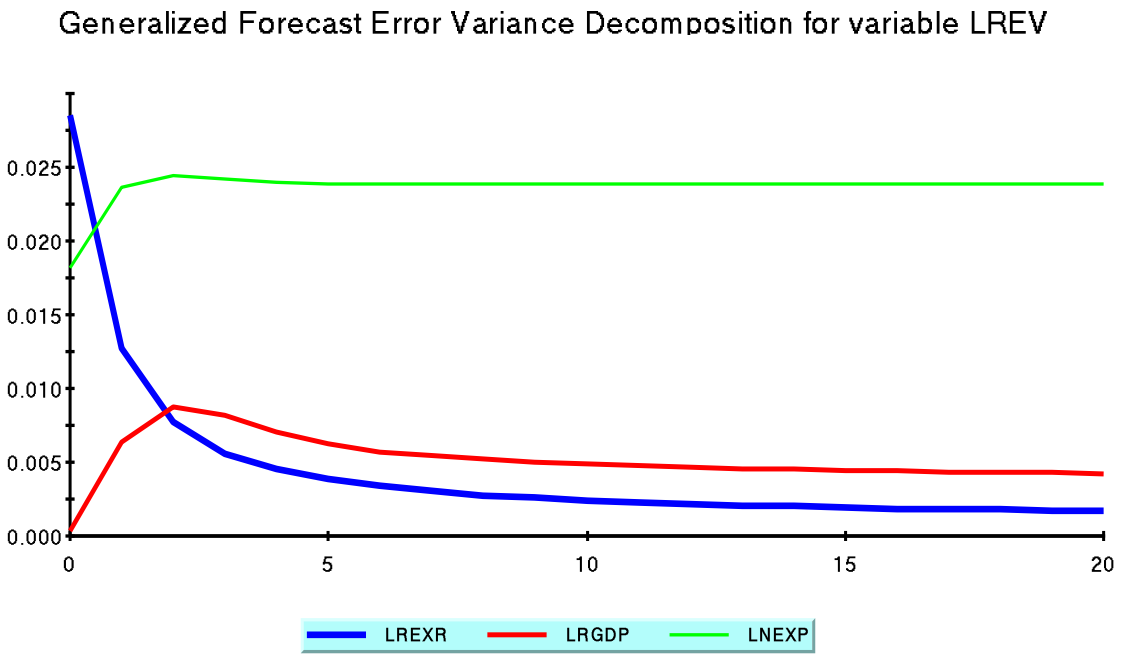


Figure 2: IRF when shocked LREXR

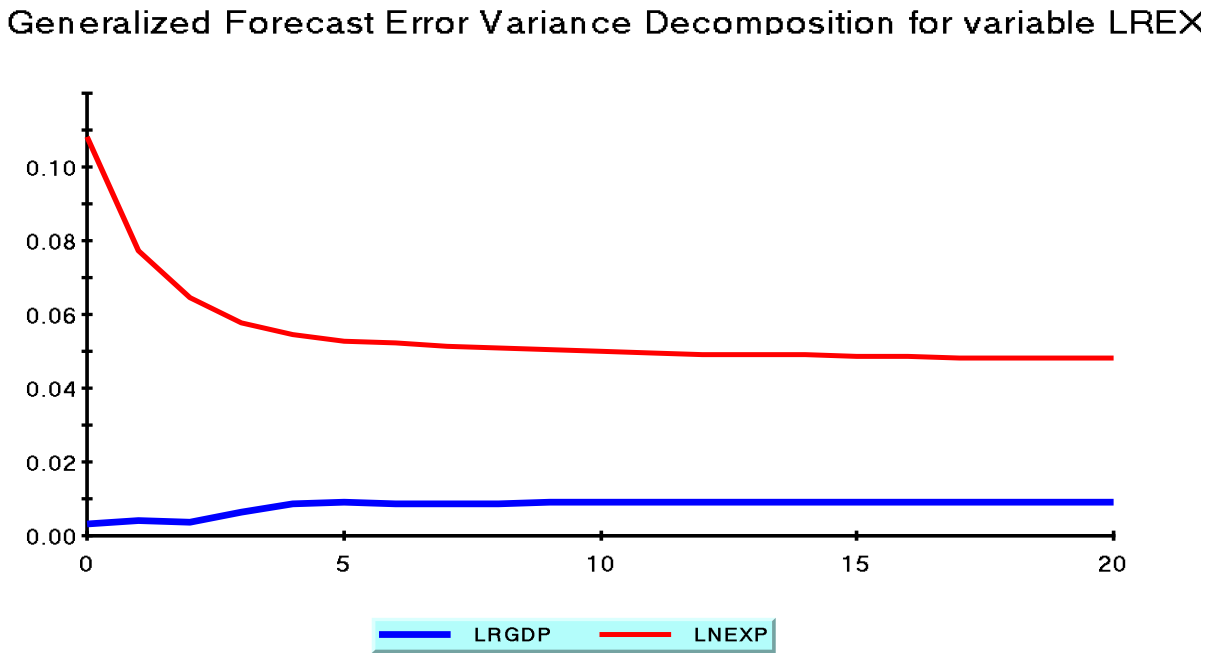
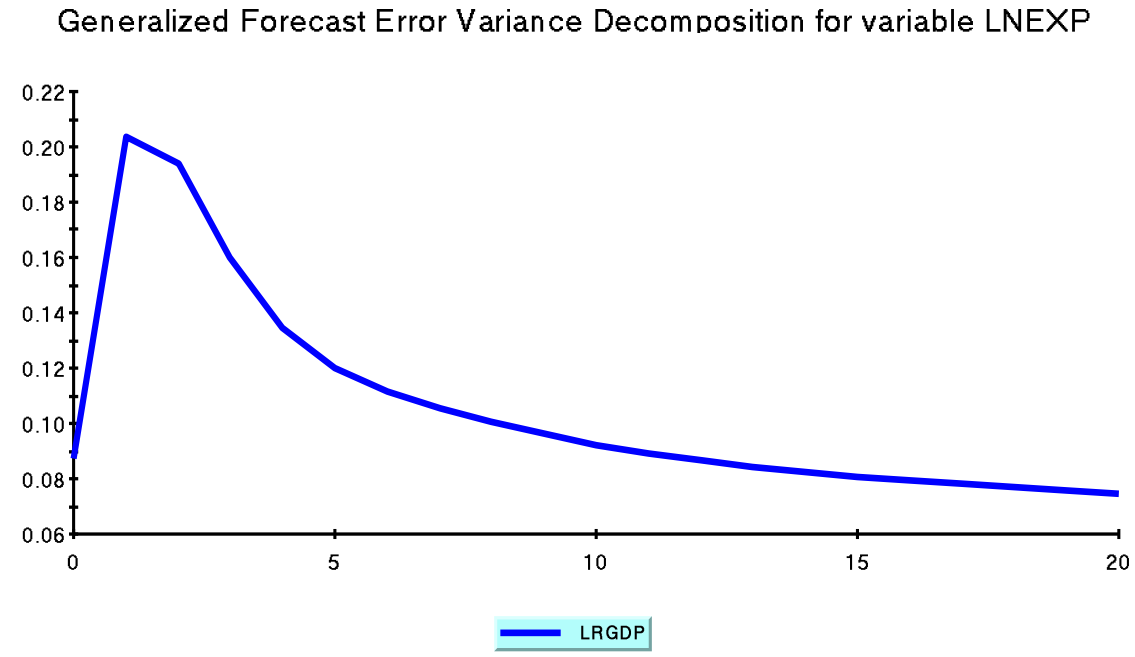


Figure 3: IRF when shocked LNEXP



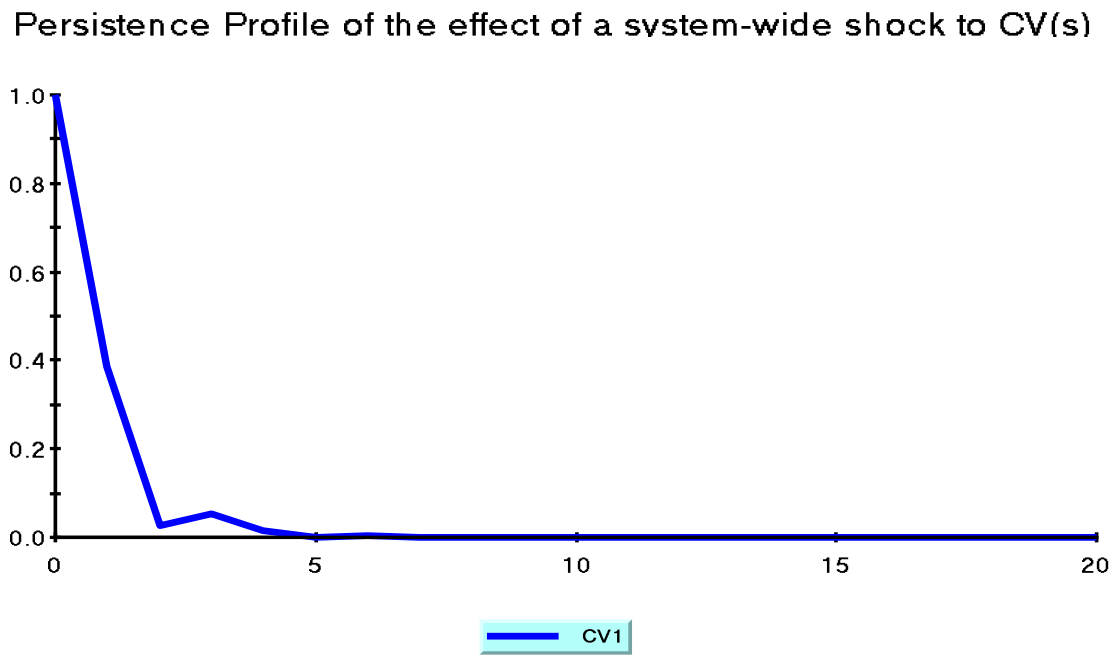
From the figures, we can interpret that shocked in foreign exchange reserve can create impact to its follower variables in VAR, the disturbance lasts for about 2 quarters.

While shocked in real exchange rate create longer disturbance, about four quarters, to its followed variables which are net export and GDP.

Persistence Profile

The persistence profile illustrates the situation when the entire cointegrating equation is shocked, and indicates the time it would take for the relationship to get back to equilibrium. The figure below shows the persistence profile for the cointegrating equation of this study.

Figure 4: Persistence Profile of the Effect of a System-wide Shock to CV



The figure indicates that it would take approximately 5 quarters for the cointegrating relationship to return to equilibrium following a system-wide shock.

Conclusion

The causality relationship between real exchange rate and economic growth has been interested by many economists. However, debate on causality relationship between the two is still unsettled.

One economic theory explained that economic growth is one of the determinants of changing in exchange rate. For example, some explained that this is because of the amount of trade balance which determined by demands of goods between the country and foreign countries. If the demand of the country goods is high, the trade balance will be positive which will increase GDP and also will result in appreciate in value of its currency. The increasing in income of domestic people may also increase the demands of foreign product, creating depreciates in currency. However, both are theories which explain the GDP as leading factor to exchange rate.

On the other hand, there is also economic theory argues that the exchange rate can create economic growth. One theory is monetary policy which explains changing in exchange rate can be a consequence from changing in interest rate (Nesiah rate). For example, when a country raises it interest rate, it will be capital flow from foreign countries which seeking higher return to their capital flow into the country to by securities and investment. This will result in appreciation of currency. On the other hand, with opposite policy implementation, the undervaluation in exchange rate will make the country products become cheaper than others, the country may able to sell more and increase its economic growth.

The economic theories can be explained in both ways of causality relationship. In addition, from the previous studies, there are empirical studies which support both theories. The causality relationship of these two variables may vary according to the context of particular countries.

However, it is still interesting to investigate the relationship between the two especially for the policy maker. If the exchange rate is exogenous to economic growth, the policy which influence to exchange rate such as foreign reserve and monetary policy are able to benefit the country. In contrast, if GDP is the leading variable to exchange rate, these policies are not valid and the country should focus more on real economic development.

Summary of the findings

This study tries to examine this relationship of REXR and Economic growth using Malaysia's economic variables. The quarterly macro-economic data including REXR GDP NEXP and REV are collected since after the Asian financial crisis until the end of 2015 and apply standard time series technique as the method to measure.

In the first steps, by applying ADF test, we found that all variables are I (1), non-stationary in level form but stationary in difference form, which according to econometric theory that most of the economic variables are non-stationary in level form and classical OLS regression is not valid to estimate the relationship. Furthermore, we found that the variables are dependent on its own past value up to two leg (two quarters).

The cointegration tests show that the variables have theoretical relationship, they are moving together in long run. Furthermore, from LRSM over identification test we found that, giving REXR as the focus variable, the real exchange rate of the country is not significantly being explained by its net export. This implies that the real exchange rate may be the leading factor to net export not the follower.

The VECM test confirms the causality between REXR and RGDP. Since it found that the RGDP is the only endogenous variable and others such as REV, REXR and NEXP are exogenous. The exchange rate can influence the country's economic growth but not the other way around. Furthermore, in VDC test, we found the ranking of exogeneity between the variables. The foreign exchange reserve is the most exogenous followed by real exchange rate, net export and growth. The econometrics said that shocking in more exogenous can affect the less but not vice versa. It is not surprising that REV is the most exogenous because it is normally being determined by government policy and be less affected from other variables. However, it shows that this policy is essential and able to create impact on the exchange rate, net export, and GDP. In addition, since the exchange rate leads economic growth, the policies which claim to be able to influence the exchange rate, such as monetary policy, should benefit for further study.

Lastly, the study tests IRF and PP, in case when there is shock of a variable in the cointegration vectors and in case of system-wide shock. The IRF shows that when there is shock in foreign

exchange reserve and real exchange rate, the disturbance to its follower variables will lasts for about 2 quarters and 4 quarters respectively. In case of system-wide shock, PP test indicates that it takes approximately 5 quarters for the cointegrating relationship to return to equilibrium.

Policy implications and limitations of the study

Based on the study as Malaysia being a representative sample of net export developing country, we can conclude that REXR does impact economic growth on these categories of developing countries. In the case of net export developing country, REXR should be used as a stable and effective tool of when formulating the policy of the economy. In the short run, we suggest the implementation of monetary policy by monitoring capital flow and targeting on REXR. However, the changes in the aggregate demand should also be taken into account when formulating the policies.

This is a humble attempt to find the causal relationship between REXR and economic growth in order to assist policy makers. However, readers should bear in mind that the findings are based on the Malaysian economy only and the methodology used also has limitations of its own. The study can be further enhanced using other econometric methods such as Panel Techniques to study the economic variables of a group of developing countries to see if the results of this study are supported and to make the policy implications strong enough for the governments to use in designing their policies for economic growth.

References

Aguirre, Alvaro and Cesar Calderon (2005) Real exchange rate misalignments and economic performance, Central Bank of Chile, Working Paper No.315.

Berg, Andy, Jonathan Ostry, and Jeromin Zettelmeyer (2008) What Makes Growth Sustained?," International Monetary Fund, Working Paper No, 08/59.

Chen (2012). Real Exchange Rate and Economic Growth: Evidence from Chinese Provincial Data (1992 - 2008). PSE Working Paper no. 2012-05

Gala, Paulo (2008) Real exchange rate levels and economic development: theoretical analysis and econometric evidence, Cambridge Journal of Economics, 32(2), 273-288.

Hausmann, Roberto, Lant Pritchett, and Dani Rodrik (2005) Growth accelerations, Journal of Economic Growth, 10(4), 303-329.

Ito, Takatoshi, Peter Isard and Steven Symansky, (1996), Economic Growth and Real Exchange Rate: An Overview of the Balassa-Samuelson Hypothesis in Asia," paper presented at the Seventh Annual NBER-EASE Conference *Changes* in Exchange Rates in Rapidly Developing Countries: Theory, Practice, and Policy Issues", Hong Kong, June 19-22.

Johansen, S. (1991). Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models. *Econometrica*, *59*(6), 1551-1580.

Levy-Yeyati, Eduardo and Federico Sturzenegger (2009) "Fear of Appreciation: Exchange Rate Policy as a Development Strategy," in Gil Hammond, Ravi Kanbur, and Eswar Prasad (eds). Monetary Policy Frameworks for Emerging Markets, London, Edward Elgar Publishing.

Mankiw (2013) Macroeconomics. 8th ed. Houndmills, Palgrave Macmillan.

Pesaran, M.H. and Y. Shin (2002). Long Run Structural Modeling. Econometric Reviews, 21(1), 49-87.

Prasad, Eswar S., Raghuram G. Rajan, and Arvind Subramanian (2007) Foreign capital and economic growth, Brookings Papers on Economic Activity, 38(1), 153-230.

Razin, Ofair and Susan M. Collins (1999) Real exchange rate misalignments and growth, in Assaf Razin and Efraim Sadka (eds), "The Economics of Globalization: Policy Perspectives from Public Economics", Cambridge, Cambridge University Press.

Rodrik, Dani (2008) The real exchange rate and economic growth, Brookings Papers on Economic Activity, 2, 365-412.

Welfens, Paul (2008). Innovations in macroeconomics, 2nd ed., Berlin: Springer