Exchange rate and trade balance linkage: evidence from Malaysia based on ARDL and NARDL

Adznan, Syaima and Masih, Mansur

INCEIF, Malaysia, INCEIF, Malaysia

30 December 2018

Exchange rate and trade balance linkage: evidence from Malaysia based on ARDL and NARDL

Syaima Adznan[1] and Mansur Masih[2]

Abstract

The exchange rate is able to influence the trade balance in most of countries' economy. When a country's trade account does not net to zero – that is, when exports are not equal to imports – there is relatively more supply or demand for a country's currency, which influences the price of that currency on the world market. However, the relationship between exchange rate and trade balance is indecisive both in long run and short run. The purpose of this paper is to examine the relationship between exchange rate and trade balance in Malaysia. This study extends prior literature by using a more recent monthly time series data and relatively advanced techniques known as ARDL and NARDL. Based on this study, it is found that the relationship between these two variables exists. It also found that trade balance is worsened in the short-run in line with the J-curve theory. These results imply that there is a trade-off of depreciation between short-run and long-run, and between exporting sectors and importing sectors. Policymaker could moderately depreciate the currency to boost trade balance but needs to effectively manage the cost incurred.

Keywords: Trade Balance, Interest Rate, NARDL, ARDL, Malaysia

[1]Ph.D. student in Islamic finance at INCEIF, Lorong Universiti A, 59100 Kuala Lumpur, Malaysia.

[2] **Corresponding author**, Professor of Finance and Econometrics, INCEIF, Lorong Universiti A, 59100 Kuala Lumpur, Malaysia. Phone: +60173841464 Email: mansurmasih@inceif.org

Introduction

The economic success of Malaysia is due to its transition from an agriculture-based economy to an industry-based economy with a substantial part of its external trade. It has achieved success in specializing in high-tech goods such as electrical and electronics and built a comparative advantage in exporting such manufactured goods, more to other Asian countries than to the U.S. and the European Union. Today, the largest export market for Malaysia happens to be China, US and Singapore. Therefore, it is important to determine if there is any relationship between the ringgit and all of these foreign currencies. How have the Malaysian-Chinese, Malaysian-US and Malaysian-Singaporean trade balance responded to movements in the real Malaysian ringgit rate? Has real depreciation of the ringgit against these currencies played any significant role in improving Malaysia's competitive position and therefore its trade balance with China, US or Singapore?

Improving trade balance leads to a robust economic growth in many countries. On the opposite, when a country persistently experiences a trade deficit there could be severe negative consequences that can affect economic growth and stability. Further, a persistent trade deficit can often have adverse effects on the interest rates in that country which could affect investment. In the long run, a trade deficit could lead to the creation of fewer jobs. If the country is importing more goods from foreign companies, prices will go down, and domestic companies may be unable to produce and compete at the lower prices. The relationship between trade balance and exchange rate needs to be studied. If any relationship exists, knowledge of the extent to which the exchange rate can be stabilized is important for the management and design of both trade and exchange rate policies. For instance, policy actions aimed at stabilizing the domestic economic system can obtain uncertain results if policymakers fail to realize the degree to which real exchange rates can be applied to control exports and imports.

Currency depreciation comes with costs and benefits. A devaluation of the exchange rate will make exports more competitive and appear cheaper to foreigners, thus increasing demand for exports and enhancing exporting sector. In addition, country's assets become more attractive, causing more foreign investment and higher economic growth. However, currency devaluation has costs as imports becomes more expensive, reducing demand for imports which could damage importing sectors. Moreover, devaluation could push inflation higher as exports becoming cheaper, manufacturers may have less incentive to cut costs. Therefore, costs may increase over time.

Marshall-Lerner's theory shows that the effect of exchange rate and trade balance could be positive and negative. According to Marshall-Lerner's elasticity theory, currency depreciation could either improve trade balance or worsen trade in the long-run. This depends on the elasticity of demand of import and export. For the short-run, according to J-curve theory, deprecation is expected to initially worsen trade balance as quantity of demand is inelastic. Over time, trade balance will gradually improve to the point which could be either at a higher or at a lower level of trade balance before depreciation according by Marshall-Lerner theory.

Empirically, studies found that relationship between trade balance and exchange rate is mixed. Some studies found a positive relationship between exchange rate and trade balance, implying that currency depreciation will close the trade gap (Igue & Ogunleye, 2014)(Ahmad, Ahmed, Khoso, Palwishah, & Raza, 2014). Some studies have failed to notice any relationship between the two variables (Liew, Lim, & Hussain, 2003)(Boyd, Caporale, & Smith, 2001). Some studies found that a negative relationship, implying that Marshall-Lerner condition does not hold and quantity demand for import and export are inelastic (Bahmani-Oskooee & Ratha, 2007)(Onafowora, 2003).

Despite this study is an extensions from a study conducted by Suwanhirunkul (2018), it will contribute to the literatures in the following ways. First, as the relationship is mixed, the paper fills this gap by examining the relationship in Malaysia. Malaysia is chosen because it is a major world's exporting and importing in many products such as rice, fishery. Second, previous researches assume asymmetric effect of exchange rate; however, recent study found that trade balance reacts to exchange rate in asymmetric manner. Thus, we will perform more appropriate NARDL technique which gives more reliable result.

The findings of this research would help policymakers in many ways. First, the research finds out sensitivity of exchange rate to trade balance so that policymakers could take into account this sensitivity when designing trade and exchange rate policy. Second, the finding would show the impact of exchange rate to trade balance in each sector. This finding shows the sectors that are better off and worse off, informing policy makers not only the benefit but also the cost of depreciation.

The subsequent sections of this paper are organized as follows: Section 2 describes the theoretical underpinnings of interest rate and trade balance; Section 3 discusses the empirical evidences of prior literatures; Section 4 outlines the data and methodology used in this study; Section 5 deliberates on the results and the economic interpretation; while Section

6 concludes with policy implications and limitations as well as suggestion for further research.

2.0 Literature Review

The relationship between exchange rate and trade balance is mixed in the long-run. Igue & Ogunleye (2014) found that exchange rate depreciation have the positive relationship with trade balance in the long-run in Nigeria. Ahmad et al (2014) found that real exchange rate improves trade balance in Pakistan. Liew,Lim and Hussain (2003) found no significant relationship between exchange rate and trade balance in some ASEAN countries. Boyd, Caporale and Smith (2001) failed to find positive relationship in U.S. in the long-run. In contrast, Bahmani-Oskooee (1991) found a negative relationship between trade balance and exchange rate in some of her samples in LCD countries, concluding that in certain cases demand of import and export is inelastic. Onafowora (2003) also found negative relationship in some countries in East Asia.

In the short-run, empirical studies also have mixed result. Boyd, Caporale and Smith (2001) found the presencse of J-curve, showing that depreciation causes worsen trade balance in the very short-run and trade balance gradually improves to the point, not significantly different from the initial point. Thus positve relationship is not found. In contrast, Ahmad et al (2014) found the inverse J-curve in which depreciation initially improves trade balance sharply. Then it gradually declines over time to the point which trade balance is better off than before depreciation. Bahmani-Oskooee (1991) found no presence of J-curve in some countries of her sample.

These findings of these studies come from different methods, most of which assume asymmetry of exchange rate. However, asymmetry of exchange rate is evidenced as Bussière (2013) points out that non-linearity and asymmetries in the trade balance/exchange rate relationship can be attributed to adjustment cost, price rigidities and quantity restrictions. The asymmetric nature could also be caused by the presence of market power, government interventions and the actions of market participants. Non-asymmetric effect of exchange rate implies that speed of adjustment of trade balance when exchange rate is negatively and positively shocked are different. Assumption that these effects have an equal response from depreciation and appreciation could result in an unreliable result.

However, many previous papers does not take into account asymmetry effect of exchange rate. Igue & Ogunleye (2014) uses ARDL method to examine the relationship but the technique does not take into account the asymtric nature of exchange rate. Ahmad et al

(2014) used Johanson's method to explore the relationship. He found the positve relationship but the Johanson's does not take into account of asymetric nature. Bahmani-Oskooee (1991) applied traditional OLS regression which has many limitations. For example, long-run effect is removed and theoretical relationship is assumed. Onafowora (2003) applies Johanson's cointergration technique with LRSM which does not test for asymmetry. Thus, our paper applies NARDL method which gives more reliable result.

3.0 Theoretical Framework

In modern macroeconomic literature, the determinants of export and import flows in small countries with open economies are derived from models contemplating trade between two countries with a representative agent (see Lombardo, 2011, Ostry 1988, Obstfeld and Rogoff 1995, Reinhart 1995). The export and import demand functions are obtained by a dynamic optimisation process, in which the agent maximises his intertemporal utility for the consumption of two types of goods: one produced on site (not marketable) and an- other that is imported (marketable), subject to an intertemporal budgetary constraint. The long-run effect of exchange rate on trade balance is explained by Marshall-Lerner while the short-run effect by J-curve theory.

Long-run effect

According to Marshall-Lerner theory, depreciation of domestic exchange rate decreases relative price of exporting goods and increases relative price of importing goods. This is called "relative price effect". As a result, domestic goods are relatively cheaper than foreign goods. Foreigners will buy more domestic goods (higher domestic exporting quantity). At the same time, foreign goods are more expensive relatively than domestic goods. As a result, domestic consumers buy less foreign goods (lower domestic importing quantity). The change in the domestic quantity demand of foreign goods and in the foreign quantity demand of domestic good is termed "volume effect".

The net impact of depreciation on value of export depends on the magnitude of price effect and volume effect. If the volume effect (an increase in quantity export) exceeds the price effect (a decrease in exporting price), the value of export increases. Similarly, the net impact on value of import depends on the magnitude of price effect and volume effect. If volume effect (a decrease in quantity import) exceeds price effect (an increase in importing price), the value of import decreases. The net effect on trade balance (difference between value of export and value of import) will depend on the effect of depreciation on value of

export and value of import. If depreciation increases value of export and decreases value of import, trade balance will improve.

As we have discussed, value of export and value of import will depend on volume effect. Volume effect depends on the price elasticity of domestic demand on foreign goods (demand for import) and price elasticity of foreign demand on domestic goods (demand for export). When demand is elastic, change in quantity demand is very sensitive to relative price change. A small change in relative price causes a large change in demand. Thus, volume effect is greater than relative price effect.

There are several cases when domestic exchange rate depreciates.

1. Quantity demand for export and import are elastic.

   The volume effect is greater than the relative price effect. Value of export will increase, and value of import will decrease, resulting in higher trade balance.

2. Quantity demand for export and import are inelastic.

   The volume effect is weaker than the relative price effect. Value of export will decrease, and value of import will increase, resulting in a lower trade balance.

3. Quantity demand for export is elastic but demand for import is inelastic.

   The volume effect is stronger than the price effect for export. But price effect is stronger than volume effect for import. Value of export and import will both increase. Trade balance will depend on relative strength of value of export and import. If value of export increase at a greater extent than import, trade balance will increase.

4. Quantity demand for export is inelastic but demand for import is elastic

   The volume effect is weaker than the price effect for export. But price effect is stronger than volume effect for export. Value of export and import will both decrease. Trade balance will depend on relative strength of value of export and import. If value of export decrease at a greater extent than import, trade balance will worsen.

4.0 Data and Methodology

This study utilises quarterly data extracted from Bloomberg database and IMF website, for a period from first quarter of year 2000 to the first quarter of year 2018 based on data availability in the database as well as the website. This study adopts six variables. Two main variables are trade balance and real effective exchange rate while the remaining four control

variables are real domestic income and real foreign income which are China, US and Singapore. These countries are selected due to the fact that they are known to be the top three of exporters and importers for Malaysia. Table below summarises the variables used in the study

Variable	Symbol	Proxy
Trade Balance	TB	Value of exports divided by the value of imports
Real Effective Exchange Rate	RER	Unit of Malaysian Ringgit per one dollar
Domestic Income or Malaysia's income	YMY	Sum of Real GDP of Malaysia
Foreign income - China	YCH	Sum of Real GDP of China
Foreign Income- US	YUS	Sum of Real GDP of US
Foreign Income-Singapore	YSG	Sum of Real GDP of Singapore

In this study, the long-run equilibrium relationship between the trade balance and the real effective exchange rate, augmented with domestic real income and real foreign income take the following form.

$$TB_m - \alpha_0 - \alpha_1 RER_m - \alpha_2 YMY_m - \alpha_3 YCH_m - \alpha_4 YUS_m - \alpha_3 YSG_m = \epsilon_m$$

Where:

$\boldsymbol{TB_m}$ - is trade balance calculated by the value of exports divided by the value of imports.

$\boldsymbol{RER_m}$ -is real effective exchange rate and has a unit of Ringgit Malaysia per one dollar. An increase in RER_m means currency depreciation. If real exchange rate has a positive coefficient, an increase in RER_m will decrease import and increase export, resulting in higher trade balance.

$\boldsymbol{YMY_m}$ - is domestic income or Malaysia's income, represented by real GDP of Malaysia. If YMY_m has a positive coefficient, an increase in YMY_m will increase in trade balance.

$\boldsymbol{YCH_m}$ is foreign income which is the sum of real GDP of China. If YCH_m has a positive coefficient, an increase in YCH_m will increase in trade balance. According to the theory, a positive coefficient is expected as higher foreign income for China will demand more Malaysian goods, resulting in higher export and lower trade balance.

$\boldsymbol{YUS_m}$ is foreign income which is the sum of real GDP of US. If YUS_m has a positive coefficient, an increase in YUS_m will increase in trade balance. According to the theory, a

positive coefficient is expected as higher foreign income for US will demand more Malaysian goods, resulting in higher export and lower trade balance.

$\boldsymbol{YSG_m}$ is foreign income which is the sum of real GDP of Singapore. If YSG_m has a positive coefficient, an increase in YSG_m will increase in trade balance. According to the theory, a positive coefficient is expected as higher foreign income for Singapore will demand more Malaysian goods, resulting in higher export and lower trade balance.

This study adopted methodology that combines standard time series techniques, autoregressive distributed lags model (ARDL) and non-linear ARDL. Time series technique involves testing whether there is long term relationship between the variables and it does not assume causality. These are among the advantages of time series technique in comparison to the standard regression analysis.

Firstly, unit root tests will be conducted on the level and differenced forms of the variables. This step is important because co-integration tests in the standard time series technique require all variables to be non-stationary. Stationary variables are defined as variable that have constant mean, variance and covariance. If a variable is found to be stationary, this entails that there is no theoretical information in the variable, hence co-integration test cannot be performed. Three tests will be conducted, namely Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and KPSS tests. ADF test (Dickey and Fuller, 1979) takes care of autocorrelation only whilst PP test (Phillips and Perron, 1988) takes care of both autocorrelation and heteroscedasticity. The null hypothesis of both tests is there is no co-integration. On the other hand, KPSS use null hypothesis of there is co-integration between the variables (Kwiatkowski et al., 1992). Once it is confirmed that variables are non-stationary, VAR order selection will be performed to determine to optimum number of lag for variables used in the study. This step is crucial since this information will be used in Johansen co-integration test. Next, Engle-Granger co-integration test will be performed, to determine whether variables in this study are theoretically related or not (Engle and Granger, 1987). This is essential to ensure any relations between the variables are not in fact spurious. However, Engle-Granger test can only determine whether variables are co-integrated or not. It cannot identify the number of co-integrating vectors. Therefore, Johansen test is performed since this method is more advanced than Engle-Granger test. Johansen test can identify the exact number of co-integrating vectors between the variables and it is based on maximum likelihood (Johansen, 1991).

Engle-Granger and Johansen tests have their own weaknesses, though the tests can determine whether the variables move together in the long run or not. The main weakness for these tests are they require all variables to be non-stationary. Additionally, the result of co-integration tests depends on the number of lags chosen and whether or not trend is included in the test. In other words, changing the number of lags will yield different result. Another issue with Johansen test is it is bias towards accepting the null hypothesis of no co-integration. Since p-value of 10% is used, i.e. error that is acceptable if null hypothesis is rejected is only 10%, this means 90% of the time the null hypothesis will be accepted.

Therefore, this paper proposed to adopt an ARDL technique introduced by Pesaran et al. (2001), a more advanced technique compared to the standard time series. ARDL does not require all variables to be stationary and it also does not suffer from biasness like the Johansen test. ARDL is a bound testing approach that can be used even for small sample size, although this is not a concern in this study. ARDL test comprised of two main stages, the first stage is using F-test to determine whether there is long run relationship between the variables. The calculated F-statistic will be compared against the upper and lower critical values as determined by Pesaran et al. (2001). If the F-statistics fall above the upper boundary, the null hypothesis of no co-integration can be rejected and it can be concluded that the variables move together in the long run. However, if it falls below the lower boundary, the null hypothesis cannot be rejected and there is no co-integration between the variables. It is also possible for the F-statistics to fall between the two asymptotic critical values, and this would mean that no conclusive result can be made. These results hold regardless of the stationarity of the variables.

Once it is confirmed that there is a long run co-movement between the variables, the second stage in ARDL technique is estimating the long-run coefficients of the variables. The next step is Vector Error Correction Method (VECM), where error correction term is estimated to determine whether a variable is exogenous or endogenous. If an error correction term is found to be significant, this means the dependant variable actually depends on the error correction term, hence it is an endogenous variable. On the other hand, if the error correction term is insignificant, this can be interpreted as the dependant variable being exogenous or a leader. The coefficient of the error term will show the speed of adjustment to equilibrium, where a greater absolute value means a faster adjustment and vice versa. In addition, a positive coefficient means the variable will move away from the equilibrium in the long run while a negative sign means the variable will return to the equilibrium.

Although VECM can determine the endogeneity or exogeneity of a variable, it does neither tell the relative strength nor rank the variables. Thus, this study will perform variance decomposition (VDC) analysis to determine the relative strength, and this step is crucial for policy makers. There are two ways to perform VDC test, either generalised or orthogonalised VDC. Orthogonalised VDC is inferior since it is not unique and depends on the particular ordering of the VAR, but generalised VDC is unique and does not depend on the ordering of the variable. Additionally, orthogonalised approach assumes when a variable is shocked, other variables in the system are switched off. Generalised VDC on the other hand does not make such restrictive assumptions. Therefore, this study will use generalised VDC since it does not suffer from weaknesses as mentioned before. Next, impulse response function (IRF) will be conducted to see the VDC result in graphical illustration.

Notwithstanding the advantages of ARDL technique in preceding discussion, ARDL also suffer from some weaknesses. Firstly, it assumes linearity and symmetrical adjustment. Linearity means proportionate change i.e. 1% change in independent variable will lead to *x*% change in the dependant variable at all times. On the other hand, symmetrical means constant speed of adjustment from equilibrium i.e. a variable will increase and decrease at the same speed. These two assumptions are too restrictive and unrealistic especially for economic variables which have turned more and more erratic in view of globalisation where economies are more interrelated nowadays. Therefore, this study is going to relax these two assumptions of ARDL by going into non-linear ARDL (NARDL), a more advanced technique introduced by Shin et al. (2014).

Further, NARDL has many advantages as it does not assume linearity or symmetric adjustment. Instead, it enables testing linear and non-linear co-integration while differentiating the short run and long run effects of regressors to the dependant variable. If relationship between the focus variables is found to be symmetry, ARDL model is correct and can be used for further discussion. The next section that follows will discuss the results of each tests performed.

5.0 Analysis & Discussion

A prerequisite for cointegration testing is that all variables need to be nonstationary variables. Thus, we investigate the time series properties of each individual variables. First all

variables are taken in the forms of log to make variance stationary. Then first difference is taken to test whether variables are stationary in difference form. The common practice is to use the augmented Dicky-Fuller (ADF) test. Thus, we perform augmented dicky fuller test to examine the stationary of variables in their log forms and first difference.

From Table 1, ADF shows that the null hypothesis of a unit root cannot be rejected for all variables at log-form, indicating that they are nonstationary. However, with the first-differences, several variables indicate rejection of the null hypothesis of a unit root at 5% level, thus they are stationary in the first-difference forms. However, for DYCH variable no rejection of null hypothesis of a unit root at 5% level. This is shown by the value of the critical value for DYCH is higher than t-statistics, hence they are stationary.

We further investigate all of these variables by conducting the PP test. From Table 2, all variables are non-stationary in their level form as null hypothesis of unit root cannot be rejected except for LTB and LYCH. However, all including the LTB and LYCH variables become stationary when first differences are taken as null hypothesis are rejected. So long that either of the test shows non-stationary for log form and stationary for the first difference form, we will accept.

	VARIABLE	ADF	VALUE	T-STAT.	C.V.	RESULT
LOG FORM	LTB	ADF(2)=SBC	125.3806	- 2.7225	- 3.4385	Non-Stationary
		ADF(2)=AIC	130.8924	- 2.7225	- 3.4385	Non-Stationary
	LRER	ADF(1)=SBC	121.3688	- 1.2381	- 3.4154	Non-Stationary
		ADF(1)=AIC	125.7782	- 1.2381	- 3.4154	Non-Stationary
	LYMY	ADF(5)=SBC	121.0604	- 0.4198	- 3.4138	Non-Stationary
		ADF(5)=AIC	129.8792	- 0.4198	- 3.4138	Non-Stationary
	LYCH	ADF(5)=SBC	177.0683	- 0.3283	- 3.4138	Non-Stationary
		ADF(5)=AIC	185.8871	- 0.3283	- 3.4138	Non-Stationary
	LYUS	ADF(1)=SBC	241.7791	- 1.8016	- 3.4154	Non-Stationary
		ADF(3)=AIC	246.5115	- 2.3687	- 3.3795	Non-Stationary
	LYSG	ADF(1)=SBC	160.2875	- 1.6485	- 3.4154	Non-Stationary
		ADF(3)=AIC	164.7463	- 2.2038	- 3.3795	Non-Stationary

	VARIABLE	ADF	VALUE	T-STAT.	C.V.	RESULT
1ST DIFF. FORM	DTB	ADF(1)=SBC	123.7968	- 9.0016	- 2.8990	Stationary
		ADF(4)=AIC	127.5184	- 5.2086	- 2.8558	Stationary
	DRER	ADF(1)=SBC	119.9316	- 5.9473	- 2.8990	Stationary
		ADF(1)=AIC	123.2161	- 5.9473	- 2.8990	Stationary
	DYMY	ADF(4)=SBC	122.2646	- 4.7478	- 2.8558	Stationary
		ADF(4)=AIC	128.8336	- 4.7478	- 2.8558	Stationary
	DYCH	ADF(4)=SBC	176.2587	- 2.8152	- 2.8558	Non-Stationary
		ADF(4)=AIC	182.8277	- 2.8152	- 2.8558	Non-Stationary
	DYUS	ADF(1)=SBC	239.8637	- 3.7351	- 2.8990	Stationary
		ADF(1)=AIC	243.1482	- 3.7351	- 2.8990	Stationary
	DYSG	ADF(1)=SBC	159.3148	- 6.1213	- 2.8990	Stationary
		ADF(3)=AIC	162.7978	- 4.7090	- 2.9232	Stationary

Table 1: ADF test for log-form and first-difference form

	VARIABLE	T-STAT.	C.V.	RESULT
LOG FORM	LTB	- 4.3422	- 3.4432	Stationary
	LRER	- 1.1519	- 3.4432	Non-Stationary
	LYMY	- 1.7630	- 3.4432	Non-Stationary
	LYCH	- 7.1604	- 3.4432	Stationary
	LYUS	- 1.7885	- 3.4432	Non-Stationary
	LYSG	- 1.6990	- 3.4432	Non-Stationary

	VARIABLE	T-STAT.	C.V.	RESULT
1ST DIFF. FORM	DTB	- 13.1999	- 2.9904	Stationary
	DRER	- 7.6190	- 2.9904	Stationary
	DYMY	- 7.4397	- 2.9904	Stationary
	DYCH	- 21.3286	- 2.9904	Stationary
	DYUS	- 5.8068	- 2.9904	Stationary
	DYSG	- 7.4308	- 2.9904	Stationary

Table 2: PP test for log-form and first difference form

Then KPSS test is implemented. The null hypothesis of KPSS is different from ADF and PP as the null hypothesis of KPSS is stationary of variable. From Table 3, all variables are non-stationary in their level form as the null hypothesis of stationary is rejected for all variables. Interestingly, they also become non- stationary when first difference is taken. The null hypothesis of stationary is rejected in first difference form.

	VARIABLE	T-STAT.	C.V.	RESULT
LOG FORM	LTB	0.12809	0.15419	Non-Stationary
	LRER	0.13067	0.15419	Non-Stationary
	LYMY	0.14376	0.15419	Non-Stationary
	LYCH	0.13197	0.15419	Non-Stationary
	LYUS	0.10902	0.15419	Non-Stationary
	LYSG	0.12907	0.15419	Non-Stationary

	VARIABLE	T-STAT.	C.V.	RESULT
1ST DIFF. FORM	DTB	0.10361	0.37962	Non-Stationary
	DRER	0.22470	0.37962	Non-Stationary
	DYMY	0.30313	0.37962	Non-Stationary
	DYCH	0.33004	0.37962	Non-Stationary
	DYUS	0.13660	0.37962	Non-Stationary
	DYSG	0.16051	0.37962	Non-Stationary

Table 3: KPSS test for log-form and first difference form

Further, we find the order of vector autoregression. From Table 4**,** AIC gives 5 lags, SBC gives 1 lags and adjusted LR test gives 2 lags. We will choose 2 lags suggested by LR test. Choosing 2 lags is also consistent with several past studies.

Order	LL	AIC	SBC	LR test	Adjusted LR test
6	1216.0	993.9873	750.9356	------	------
5	1174.2	988.2228	784.5849	CHSQ(36)= 83.5289[.000]	36.7021[.436]
4	1129.2	979.2266	815.0024	CHSQ(72)= 173.5214[.000]	76.2443[.344]
3	1050.5	936.5355	811.7252	CHSQ(108)= 330.9035[.000]	145.3970[.010]
2	961.2812	883.2812	797.8846	CHSQ(144)= 509.4122[.000]	223.8326[.000]
1	907.7053	865.7053	819.7225	CHSQ(180)= 616.5640[.000]	270.9145[.000]
0	847.0902	841.0902	834.5212	CHSQ(216)= 737.7941[.000]	324.1823[.000]

Table 4: Order of vector autoregression

Cointegration test: Engle Granger and Johansen

Engle Granger tests the cointegration by examining the error term. If cointegration exists, residual of cointegrating relationship should be stationary. Thus, we run OLS and test for residual. From Table 5, the test shows the presence of cointegration as we reject the null hypothesis of unit root due to high value of test statistic which is greater than critical value

	Test Statistic	LL	AIC	SBC	HQC
DF	-5.5285	135.6612	134.6612	133.5588	134.2250
ADF(1)	-5.0371	136.0869	134.0869	131.8822	133.2145
ADF(2)	-3.2721	137.9278	134.9278	131.6208	133.6192
ADF(3)	-2.6905	138.2580	134.2580	129.8486	132.5132
ADF(4)	-3.3912	141.1142	136.1142	130.6025	133.9332
ADF(5)	-3.1608	141.1360	135.1360	128.5219	132.5188

Table 5: stationary test of residual

The Engle-Granger method has several limitations. Firstly, it identifies only a single cointegrating relation. Another limitation of the Engle-Granger method is that it is a two-step procedure, with one regression to estimate the residual series, and another regression to test for a unit root. Errors in the first estimation are necessarily carried into the second estimation. Finally, the Engle-Granger method estimates cointegrating relations independently of the VECM in which they play a role. As a result, model estimation also becomes a two-step procedure.

From these limitations, we perform Johansen's cointegration test. From Table 6, the null hypothesis of no cointegration is rejected at 5% significant level based on both Maximal Eigenvalue and Traces. After that, the null hypothesis of one cointegration against alternative

hypothesis of two cointegration could not be rejected at 5% significant level. Thus, we conclude that there is one cointegration.

Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

Null	Alternative	Statistic	95% Critical Value	90% Critical Value	Result
r = 0	r = 1	94.778	43.610	29.130	1 cointegration
r<= 1	r = 2	28.070	37.860	23.100	

Cointegration LR Test Based on Trace of the Stochastic Matrix

Null	Alternative	Statistic	95% Critical Value	90% Critical Value	Result
r = 0	r>= 1	183.325	115.850	110.600	1 cointegration
r<= 1	r>= 2	86.547	87.170	82.880	

Table 6: Cointegration Test based on Maximal Eigenvalue and trace of the Stochastic Matrix

Johansen's test has limitation as this test assumes that all variables are I(1). Moreover, it is sensitive to number of lags in the order of VAR. Changing number of lags will give different result. In addition, stationary test is biased as the test tend to accept the null at 95% of the time. Stationary test could be sensitive to whether trend term is presence or intercept is presence. Therefore, we perform ARDL as this test could be applied with both I (1) and I(0) and bypass many limitations.

Autoregressive distributed lags (ARDL)

Introduced by Pesaran et al (2001), the ARDL technique does not require pre-tests for unit roots. Consequently, ARDL cointegration technique is preferable when dealing with variables that are integrated of different order I(0) and I(1). The long-run relationship of the variables is detected through the F-statistic (Wald test). Long-run relationship of the series is said to be established when the F-statistic exceeds the critical value bound.

From Table 7, we test for long-run relationship and found that F-statistics in trade balance equation and Malaysia's income are higher than upper critical bound. Thus, we reject the null hypothesis of no long-run relationship and conclude that there is a cointegration among variables.

Model	F-statistics	Critical bound F statistic (95%)	
TB(TB, RER, YMY, YCH, YUS, YSG)	4.3704	I(0)	I(1)
RER(TB, RER, YMY, YCH, YUS, YSG)	2.0649	3.539	4.667
YMY(TB, RER, YMY, YCH, YUS, YSG)	2.5192		
YCH(TB, RER, YMY, YCH, YUS, YSG)	1.2575		
YUS(TB, RER, YMY, YCH, YUS, YSG)	0.88381		
YSG(TB, RER, YMY, YCH, YUS, YSG)	3.0008		

Table 7: Test of long-run relationship in ARDL

From Table 8 long-run coefficient of ARDL are estimated using the Schwarz Bayesian Criterion. Three out of five variables are significant at 5% level which are domestic income for Malaysia (YMY), foreign income for China (YCH) and foreign income for Singapore (YSG), while the rest are insignificant. All variables that are significant indicates there are long-run effect on trade balance. Real exchange rate (RER) has insignificant but positive relationship with trade balance at 5% level. This implies that 1% depreciation (increase in RER) will increase trade balance by 0.071 %. Intuitively, the devaluation of the Malaysian Ringgit will decrease prices of Malaysian's exports abroad and increase the price of imports at home, inducing export quantity to rise and import quantity to decrease, thereby influencing the trade balance positively. But since RER is insignificant, this indicates that there are no long-run effect on trade balance.

Domestic income (YMY) has a negative and significant relationship with trade balance as higher income of Malaysian people will demand more foreign products which increases import. Thus, trade balance is lowered in the long-run. Foreign income for China (YCH) and Singapore (YSG) have positive and significant relationship with trade balance. This indicates as those foreign income increases, other countries will demand more export from Malaysia, resulting in higher net export and trade balance.

Regressor	Coefficient	P-value
RER	0.071	0.317
YMY	-0.607	0.000*
YCH	0.396	0.000*
YUS	0.032	0.350
YSG	0.660	0.000*

Table 8: long-run coefficients of ARDL

Cointegration tells us that there is a long-run relationship between variables. However, there could be a short-run deviation from the long-run equilibrium. Cointegration does not tell the process of short-run adjustment to bring about long-run equilibrium. Thus, we will proceed to error-correction model to examine the short-run dynamics. Prior to that, We will apply NARDL model given ARDL model has limitation as it assumes symmetric change of trade balance when exchange rate depreciates and appreciates.

Non-linear autoregressive distributed lags (NARDL)

Bussiere (2013) points out that non-linearities and asymmetries in the trade balance/exchange rate relationship can be attributed to adjustment cost, price rigidities and quantity restrictions. With currency depreciation, exports are cheaper and more competitive in foreign currency terms. Therefore, exporters tend to gain as they increase their exports with an assumption that their prices remain the same in their home currency terms. However, it is not possible to increase the quantity exported due to full capacity or adjustment costs are too high, they may increase their prices instead.

On the other hand, with appreciation, exports become more expensive and less competitive in foreign currency terms. Thus, exporters will lose if they do not change(lower) their prices in domestic currency terms. However, lowering export prices after some point is difficult since falling export prices imply falling profit margins. The downward rigidity of prices suggests a lower response to appreciation than to depreciations. The asymmetric nature could also be caused by the presence of market power, government interventions and the actions of market participants.

Another cause of asymmetry is that when the currency depreciates, exporting firms enter the markets quickly due to higher demand for export which increases production of exporting goods. But when currency appreciates, these firms are more reluctant to cut down production in the short-run as they have put forward a lot of investment in exporting activity. Thus, currency depreciation could affect trade balance at a faster rate than does appreciation. This is one reason why speed of adjustment of trade balance to exchange rate appreciation and depreciation are different.

For the purpose of NARDL test, this paper will only focus on two variables, namely interest rate and trade balance, consistent with the thesis statement of this study which is determining whether interest rate influence the trade balance of Malaysia. Hence, this paper would like to know the relationship between these two variables, specifically whether there exists a long run relationship between them and whether the relationship is linear or non-linear.

Co-integration test statistics

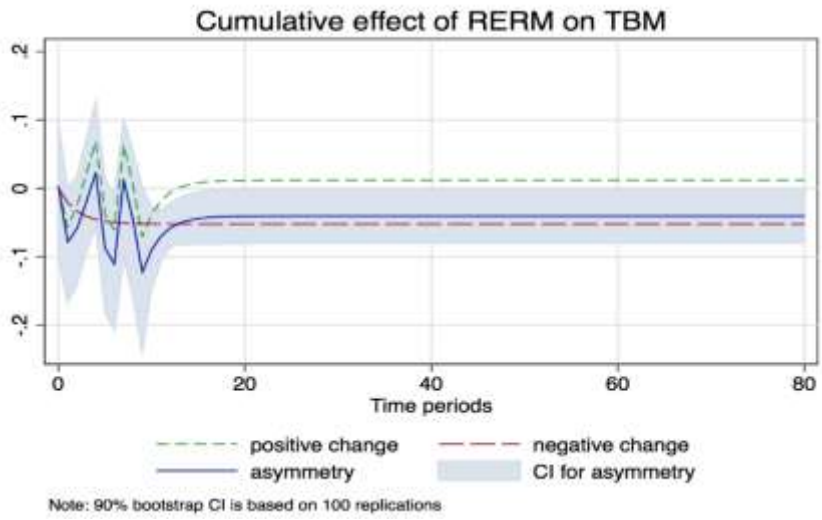
Variables	F-statistics	Critical Lower Bound	Critical Upper bound	Conclusion
IN	4.9250	3.79	4.85	Co-integration

Based on the NARDL test, the first test of long run co-integration reveals that the F-statistics is higher than the critical upper bound at 5% significance level, hence null hypothesis of no co-integration is rejected. In other words, interest rate and inflation rate are co-integrated in the long run.

Wald test for long run and short run symmetry

Independent: Interest rate	F-statistics	p-value	Selected specification
Long run	1.787	0.187	Symmetry
Short run	0.2247	0.638	Symmetry

As for the Wald test for symmetries, it can be seen that the p-values for both long and short run is insignificant, thus the null hypothesis of symmetry in long and short run cannot be rejected. In other word, NARDL test shows that the relationship between interest rate and trade balance is symmetry in long and short term, hence symmetric ARDL model is suitable for this study. The graph below shows the cumulative effect of inflation on interest rate all lies within the confidence interval for symmetrical relationship (i.e. shaded area).



The symmetrical relationship between these two variables may be due to decisions by policy makers to keep interest rate and trade balance stable since Malaysia as a developing economy

is highly dependent on foreign investment. Thus, it is imperative for the Malaysian government to keep interest rate stable to retain investor confidence. Failure to do so may result in capital outflows and this would have adverse impacts on GDP. Keeping inflation rate stable could also be for political reason to win the people's vote and accelerating inflation may cause the public to lose trust in the government.

Vector Error Correction Model (VECM)

ECM	Coefficient	Standard Error	T-Ratio [P. value]	Conclusion
DTB	-0.13964	0.11486	1.2157[.230]	Exogenous
DRER	-0.03727	0.13291	0.2804[.780]	Exogenous
DYMY	-0.32376	0.10114	-3.2012[.002]*	Endogenous
DYCH	-0.59939	0.06644	-9.0214[.000]*	Endogenous
DYUS	-0.00686	0.01881	0.3649[.717]	Exogenous
DYSG	-0.05139	0.06812	-0.7543[.454]	Exogenous

Table 9: VECM Coefficients of error correction models

In VECM test, a p-value of less than 10% means the null hypothesis of exogenous variable is rejected, hence the variable is endogenous. Further, when the coefficient is significant, that dependent variable bears the burden to bring about equilibrium. Thus, it is endogenous. If it is not significant, the dependent variable is exogenous. From Table 9, as error-correction term are significant for domestic income (DYMY) at 5% level and foreign income for China, they are endogenous. The significant of error-correction coefficient confirms our finding of a significant long-run co-integration relationship between variables. The error-correction term is not significant for trade balance (DTB), real exchange rate (RER), foreign income for US (DYUS) and foreign income for Singapore (DYSG) hence they are exogenous.

Intuitively, foreign income is an exogenous variable because a change in foreign income is an external shock which could not be controlled by one country. But this is not the case for China, the reason could be due China is the largest export market for Malaysia (Oskooee and Aftab, 2018). Real exchange rate (RER) is exogenous as Malaysia exchange rate is against dollars which its supply and demand is determined in a global market. Domestic income represented by Malaysia's real GDP could be influenced by internal factor such as fiscal and monetary policies. Trade balance is exogeneous as it depends on many domestic factors, for example, real exchange rate as depreciation increases net export.

Further, VECM does not show the relative exogeneity or endogeneity, neither does it explicitly tell whether real exchange rate can be used to influence trade balance or not.

Nevertheless, since foreign income for china is the only endogenous variable for foreign income and the causality is from exchange rate to trade balance, the result preliminary shows that exchange rate may be ineffective in controlling trade balance. Table 9 also indicates that all signs are negative for the coefficients of error correction terms which means that all variables will return to its long run equilibrium value. On the other hand, the size of absolute coefficients shows the speed of adjustment to equilibrium once there is a shock. Based on the result, domestic income and foreign income for China speed of adjustment to equilibrium is relatively faster than other variables. We will further will proceed with VDC.

Variance Decomposition (VDC)

	HORIZON	LDA	LDM	LDP	LES	LFA	LFE	RANKING
LTB	**10**	67.97%	5.51%	13.06%	5.58%	0.50%	7.37%	3
LRER	**10**	0.08%	75.10%	14.82%	6.30%	3.42%	0.28%	1
LYMY	**10**	5.14%	22.80%	16.66%	4.51%	27.14%	23.74%	6
LYCH	**10**	5.88%	52.88%	5.47%	23.87%	4.14%	7.76%	5
LYUS	**10**	0.49%	3.31%	12.13%	1.84%	69.73%	12.51%	2
LYSG	**10**	3.44%	38.62%	2.34%	2.23%	11.95%	41.42%	4
	HORIZON	**LDA**	**LDM**	**LDP**	**LES**	**LFA**	**LFE**	**RANKING**
LTB	**20**	67.79%	5.72%	13.58%	5.55%	0.36%	7.01%	3
LRER	**20**	0.06%	74.19%	15.70%	6.13%	3.68%	0.24%	1
LYMY	**20**	5.42%	25.81%	13.54%	4.85%	26.05%	24.33%	6
LYCH	**20**	5.52%	58.43%	7.69%	20.57%	1.94%	5.84%	5
LYUS	**20**	0.55%	2.74%	12.76%	1.64%	70.11%	12.21%	2
LYSG	**20**	3.14%	41.72%	2.77%	2.44%	9.97%	39.96%	4

This study uses generalised VDC given its strength over the orthogonalised approach. A variable is deemed as the most exogenous if the forecast error variance is mostly explained by its own shock. The finding indicates that the ranking is consistent for forecast horizon of 10 and 20 months. Real exchange rate is the most exogenous variable of all, followed by foreign income for US, trade balance, foreign income for Singapore, China and finally the domestic income of Malaysia is the most endogenous. It is consistent with VECM results given YMY and YCH are endogenous. The casual chain from exogenous (left) to endogenous (right) is per below diagram

From both VECM and variance decomposition, the causality between our two focus variables shows that exchange rate is a leading variable while trade balance is a following variable. The result suggests to the policy makers that trade balance could be manipulated by changing exchange rate. Our findings are in line with other research which found impact of real exchange rate on trade balance. To improve trade balance, policymaker could depreciate exchange. The Bank of Malaysia could to some extent manipulate exchange rate by controlling the supply or demand of Malaysian Ringgit by, for example, issuing bonds to decrease amount of Malaysian Ringgit circulation in market. The policymaker could not affect the world income which is the most exogenous.

Impulse response function

We applied the generalized IRFs. Impulse response function is a graphical representation of VDC when an equation is shocked by one SD. From Figure 3, when real exchange rate is shocked, trade balance becomes more volatile until approximately 4 quarters and become stable after the fourth quarter. Consistent with earlier results, the trade balance variable is more sensitive to a 1% SD shock to the real exchange rate variable by comparing with sensitivity of exchange rate variable when trade balance variable is shocked in Figure 4. This shows that trade balance is following variable and exchange rate is leading variable.

Figure 3: Generalized impulse responses to one SE shock in the equation of LRER.

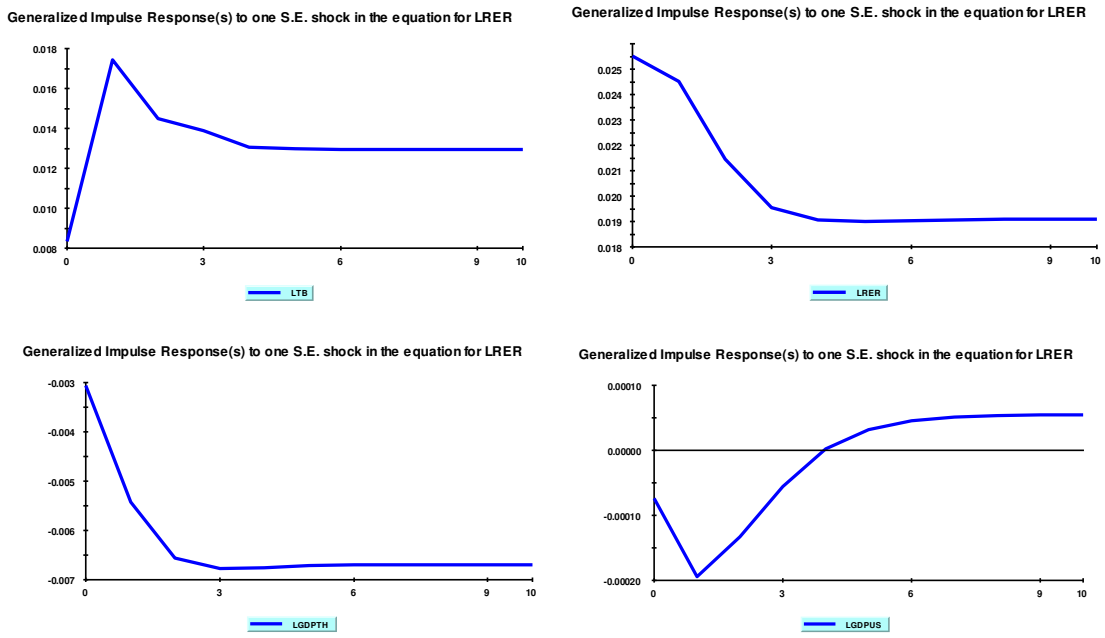
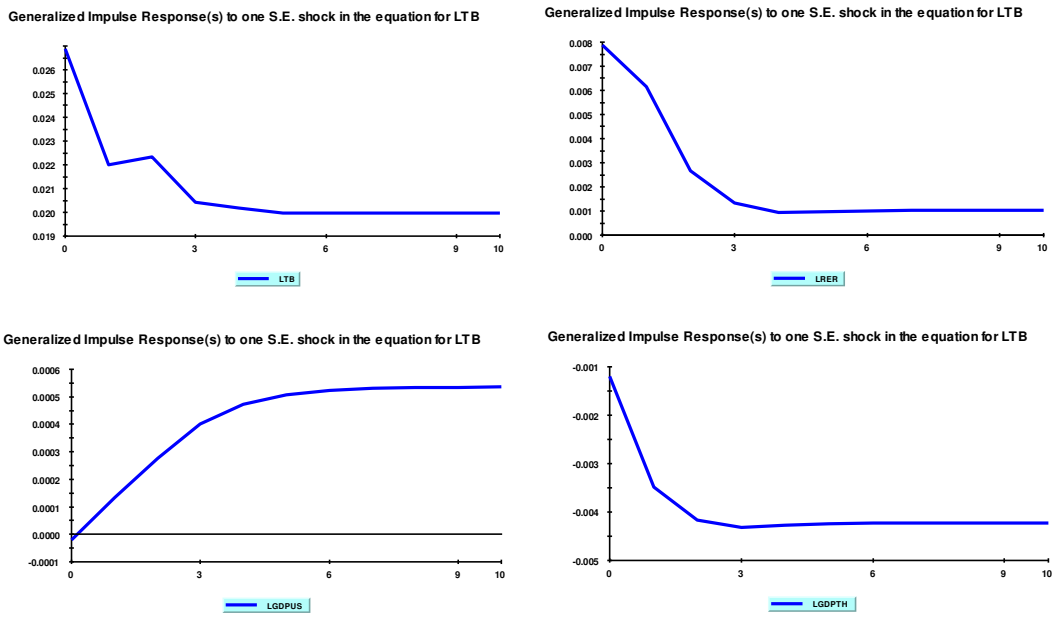


Figure 4: Generalized impulse responses to one SE shock in the equation of LTB.



Persistence Profile (PP)

Based on Figure 5, an application of persistence profile indicates that if the whole co integration relationship of Malaysia as the whole country is shocked, it will take about 13 quarters (about 3 years) for the equilibrium to be restored.

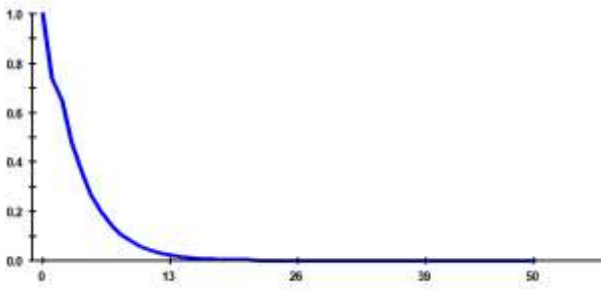


Figure 5: Persistence profile of the effect of a system-wide shock

Conclusions and Policy Implications

As findings of previous literature suggest that effect of exchange rate on trade balance is still inconclusive, the result of this research shows a positive relationship in which exchange rate leads trade balance and confirms the positive relationship of many previous literature. Although Marshall-Lerner theory points out the case that currency depreciation could lead to a negative trade balance, our result implies that, for the country level, negative relationship is not likely as positive the world's demand for import and export are relatively elastic.

Depreciation of Malaysian Ringgit will improve trade balance and income of the whole country as Malaysian's economy depends largely on exports. Our finding shows that trade balance is quite sensitive to real exchange rate. The long-run coefficient is large and significant, implying that relatively small depreciation will result in relatively larger trade balance. However, policy makers need to take in account the cost of deprecation. Deprecation could worsen trade balance in the short-run as quantity demand for import and export are inelastic, causing lower value of export and higher value of import. It could take many quarters to realize the full effect of depreciation due to fixed contracting and negotiating terms of domestic exporters.

Policymaker such as Bank of Malaysia and relating government agencies should also consider the effect of various sectors. Past studies reveals that currency depreciation enhances economy of the whole country, depreciation improve trade balance of net exporting sectors at the cost of net importing sectors. Many companies in importing sectors are small and medium sized domestic companies and many imported goods are used to produce domestic products, a large depreciation could significantly lower competitiveness of these companies and heavily damage these sectors in the long term.

Thus, policy makers are suggested to find the optimal exchange rate that lead to the optimal benefit, considering both short-term and long-term costs. The policy maker could depreciate the currency moderately if needed to boost economic growth but should not ignored the costs. Trade balance would be negatively affected in the short-run and importing sectors would face a higher importing cost. Since trade balance is found to be sensitive to exchange rate, immediate and sharp depreciation is not recommended as it could create a severe negative shock to importing sectors.

Our finding supports the evidence that during economic crisis in 1997 Malaysia is heavily damaged when it sharply and immediately depreciates its currency by a large amount, causing short-run and medium-run severe impact to the economy and many small and medium domestic companies. As economic policy usually has trade-off, when depreciate the currency the government could use some portions of higher revenue gained in net exporting sectors to support less competitive importing countries. A further research needs to be investigated to find the optimal exchange rate and the optimal range in which exchange rate could be depreciated and appreciated. Limitation of this paper is that it covers two main trade theories namely J curve and Marshall's Lerner. Future research could explore more trade theories with Malaysian data or using other countries' data.

References

Ahmad, N., Ahmed, R., Khoso, I., Palwishah, R., and Raza, U. (2014). Impact of exchange rate on balance of payment: an investigation from Pakistan. *Research Journal of Finance and Accounting,* 5(13), 32 -42.

Bahmani-Oskooee, M. (1991). Is there a long-run relation between the trade balance and the real effective exchange rate of LDCs? *Economics Letters*, 36(4), 403–407.

Bahmani-Oskooee, M., and Ratha, A. (2007). The bilateral J-curve: Sweden Versus her 17 Major trading partners. *International Journal of Applied Economics*, 4(1), 1–13.

Boyd, D., Caporale, G. M., and Smith, R. (2001). Real exchange rate effects on the balance of trade: Cointegration and the Marshall–Lerner condition. *International Journal of Finance & Economics*, 6(3), 187–200.

Bussière, M., Callegari, G., Ghironi, F., Sestieri, G., and Yamano, N. (2013). Estimating trade elasticities: Demand composition and the trade collapse of 2008-2009. *American Economic Journal: Macroeconomics*, 5(3), 118–151.

Igue, N. N., and Ogunleye, T. S. (2014). Impact of real exchange rate on trade balance in Nigeria. *African Development Review*, 26(2), 347–358.

Liew, K.-S., Lim, K.-P., and Hussain, H. (2003). Exchange rate and trade balance relationship: The experience of ASEAN countries. *International Trade*, 5(3), 1–11.

Onafowora, O. (2003). Exchange rate and trade balance in East Asia: is there a J-curve. *Economics Bulletin*, 5(18), 1–13.

Pesaran, M. H., Shin, Y., and Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, 16(3), 289–326.

Shin, Y., Yu, B., and Greenwood-Nimmo, M. (2014). Modelling asymmetric cointegration and dynamic multipliers in an ARDL framework. In Horrace, W.C. and Sickles, R. C.(eds), Festschrift in Honor of Peter Schmidt. Springer Science & Business Media, New York, 281-314.