Testing for Marshall-Lerner Condition: Bilateral Trades between Malaysia and Trading Partners

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***Abstract*—In this paper, empirical approaches are applied to test the validity of Marshall-Lerner condition, i.e. if devaluation in real exchange rate helps to improve the trade balance of domestic country. The analyses are focused on five pairs of bilateral trades between Malaysia and its main trading partners of China, EU, Japan, Singapore and U.S. respectively. Applying the Least Square and Fully Modified Least Square approaches, our results fail to show the validity of Marshall-Lerner condition in all five pairs of bilateral trades. However, our results show that higher income level of trading partners may lead to improvement in the trade balance of domestic country.**

***Index Terms*—trade balance, exchange rate devaluation, Marshall-Lerner condition, cointegration.**

I. Introduction

The impact of exchange rate on economics is always an interesting topic to be studied especially in the context of emerging economies. One of the impacts of exchange rate is through trade balance. The impact can be studied through price effect and quantity effect. The depreciation of exchange rate may lead to the changes in relative prices between imported and exported goods. The price effect takes place when depreciation of exchange rate makes imported goods more expensive than exported goods. Producer will adjust their volume of production in response to changes in prices which leads to deterioration in trade balance in the short run. However, cheaper exported goods may attract higher demand on domestic goods and the volume of production increase. Hence the quantity effect may improve the trade balance in the long run. This phenomenon, i.e. depreciation of exchange rate leads to improvement in the trade balance in the long run is named as Marshall-Lerner condition.

In this paper, we conduct empirical analyses to test the validity of Marshall-Lerner hypothesis in the bilateral trade between Malaysia and its main trade partners, for the period of 1980–2012. We fail to prove the validity of Marshall-Lerner condition in all five pairs of bilateral trades. Our results reveal that higher income of foreign trade partner may improve the trade balance of domestic country.

II. Literature Review

A. Theoretical Model and Concept

The modeling on the relationship between exchange rate and trade balance is discussed in many papers. The below discussion can refer to the paper by [1].

Theoretically, real exchange rate, E_t is defined to be domestic price level, P_t multiplied by nominal spot exchange rate, S_t and divided by foreign price level, P_t^*.

$$E_t = \frac{S_t P_t}{P_t^*} \tag{1}$$

On the other hand, trade balance is calculated as the ratio of total export divided by total import as shown in equation (2):

$$B_t = \frac{P_t X_t}{P_t^* S_t M_t} \tag{2}$$

where total export is obtained by multiplying domestic price level with volume of export while total import calculated as foreign price level multiplied by nominal spot exchange rate and the volume of import. By expressing equation (2) into logarithms form (using lower case letters),

$$b_t = x_t - m_t - \left(s_t - p_t + p_t^*\right) = x_t - m_t - e_t \tag{3}$$

We define the long run demand functions for export and import as in equation (4) and (5):

$$x_t = \alpha_x + \beta^* y_t^* + \gamma_x e_t \tag{4}$$

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$$m_t = \alpha_m + \beta y_t + \gamma_m e_t \tag{5}$$

where y_t^* and y_t are the real income for foreign country and domestic country respectively; γ_x and γ_m are the elasticities of export and import respectively. Taking both equations into trade balance equation in (3), we finally get the long run trade balance equation as below:

$$b_t = (\alpha_x - \alpha_m) + \beta^* y_t^* - \beta y_t + (\gamma_x + \gamma_m - 1) e_t \tag{6}$$

For Marshall-Lerner condition to be hold, we should fulfill the following condition:

$$(\gamma_x + \gamma_m - 1) > 0$$
$$\gamma_x + \gamma_m > 1$$

B. Empirical Review

Despite being studied numerous times, there is still no conclusive evidence to proof a general validity of Marshall-Lerner theorem. Nonetheless, there are relatively more literatures that supported the existence Marshall-Lerner (ML) condition.

Existence of ML condition in Asia were recorded by [2] for Malaysia (from 1960 to 1974), Singapore (1973–1990), Philippines (1960–1993), Thailand (1973 – 1980) and Indonesia (1970–1992); [3] for South Korea's bilateral trade with Japan and United States (1980–2006); [4] and [5] for Bangladesh; [6] for Malaysia (1955–2006), [7] for Pakistan; and Noland for Japan (1970 – 1985). Meanwhile, [8] reported ML condition holds in Brazil; [9] in Argentina; [10] in Malta; [11] in Turkey; [12] in Norway; [13] in Columbia; and [14] on Russia's non-fuel trade. Studying United State's trade with G7 countries, [15] found both L-curve (delay effect for 6 months) and ML condition hold for five out of the six countries (Canada, France, Germany, Italy, Japan and United Kingdom), exception is Italy.

Among other past literatures that support ML condition exists in various countries include [15]-[22]. [23] revealed positive and significant relationship between exchange rate increase (devaluation) and trade balance for France, Finland and New Zealand but negative and significant results for United Kingdom and Guyana. [24] found negative but very weak correlation between current account and exchange rate while [25] reported long-run cointegration. The later also reported no causality evidence. [26] found ML condition for Turkey's trade existed with seven of its nine largest trading partners, namely Austria, Belgium, England, Germany, Holland, Italy and United States for the period between 1960 and 2000. The two exception countries are France and Italy. Interestingly, [8] found ML condition holds for bilateral trade between Brazil and Italy. [27] revealed marginal impact between real exchange rate and trade balance in Sri Lanka.

Nonetheless, there are also literatures whose claimed ML condition is not statistically supported. Among them are [28] who studied on selected OECD countries (United Kingdom, Canada, Germany, Japan, and the United States); [29] on Sweden; [30] on ASEAN countries; and [31] on United States and Singapore. Studying Gulf Corporation Council countries of Kingdom of Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and United Arab Emirates for the period between 1980 and 2006, [32] claimed ML condition does not hold. Other findings not supporting ML condition are [33], [34] and [35].

Various reasons of not fulfilling ML condition being proposed by previous literatures. [15] and [36] believe that Italy's high inflation countered the positive effect of devaluation. Lengthy lag time may also affect the validity of ML condition. Among reported lag time adjustments are three quarters as in [17], six quarters as in [16] and two years as in [15]. Meanwhile, [29] and [30] claimed that trade balance is more responsive to income effect and real money respectively as compared to exchange rate. Other reasons possibly affecting the validity of ML condition include effect of exchange rate volatility with level of exporters' risk tolerance as in [37] and [38] that exchange rate misalignments and price rigidity. Exchange rate system also plays an influencing role with more literatures found fixed regime likely enable validity of ML condition as mentioned in [8], [9] and [12].

C. Research Background–Bilateral Trades of Malaysia

Malaysia has been part of World Trade Organization (WTO) since 1995. Besides, Malaysia has been members of various trade commitments or co-operations such as ASEAN Free Trade Area (AFTA), Asia Pacific Economic Co-operation (APEC), South-South Cooperation and many others bilateral free trade agreement (FTA). [39] reported that Malaysia's AFTA utilization ratio (share of export under FTA scheme) rose from merely 1.2% in 19% to 17.8% in 2010. United Nations Commodity Trade Statistics (COMTRADE) data shows that Malaysia's total merchandise exports and imports for year 2011 are about US$228.1 billion and US$187.5 billion respectively. Its top destinations of merchandise export are China (13.1%), followed by Singapore (12.7%), Japan (11.5%), European Union (10.4%) and United States (8.3%). Its top destinations for merchandise import also follow same order as export. Manufacturer products are top merchandise export component at 62% of total. "Fuel and mining" products amounted to 20.2% while agricultural export amounted to 17.1%. Merchandise import component also followed export ranking order.

Meanwhile, Malaysia's commercial service exports and import for year 2011 totaled US$35.9 billion and US$38.3 billion respectively. There is no top destination information for commercial services export or import. Three top items of commercial service export import are highlighted. Travel is top commercial service export component (54.6%) but only ranked third for principle service import items. Transportation is the second highest service import items but ranked third in export category. "Other commercial services" item is top import and second in export category for year 2011.

III. DATA

In this paper, we test the validity of Marshall-Lerner through the bilateral trade between Malaysia and its five main trading partners of China, EU, Japan, Singapore and U.S. respectively. In particular, we intend to investigate if devaluation of exchange rate will improve the trade balance in the long run. There are four variables used in this analysis namely the trade balance (TB), real exchange rate (RER), the income of trading partner (Y*)and the income of domestic country (Y). The trade balance is proxy by the ratio of total export/ total import while the real exchange rate is proxy by the real effective exchange rate based on consumer price and the income (Y*) and (Y) are proxy by industrial production index. The data for industrial production index is collected from Datastream while the other data are obtained from International Monetary Fund (IMF) and the data spans from year 1980 to 2012. All data are transformed into logarithm form. The detail of the data is as summarized in Table I.

TABLE I. DATA SOURCES

Variable	Data	Period	Source
Y	Log of Industrial production index for country i	1980-2012	Datastream
RER	Log of real effective exchange rate for Malaysia	1980-2012	IMF
TB	Log of the ratio of export/ import for Malaysia	1980-2012	IMF

IV. METHODOLOGY

A. Augmented Dicky-Fuller (ADF) Unit-Root Test

Unit-root test is used to identify if a series is stationary or non stationary. Assume a series follows an AR (*p*) process:

$$y_t = \alpha_1 y_{t-1} + \ldots + \alpha_p y_{t-p} + u_t \tag{7}$$

This equation can be written in lag operator form:

$$\left(1 - \alpha_1 L - \ldots - \alpha_p L^p\right) y_t = u_t \tag{8}$$

To test the stationarity process of $\alpha(1) = 1 - \alpha_1 - \ldots - \alpha_p = 0$, we can reparameterize equation (7) by subtracting y_{t-1} on both sides and rearranging terms to give (see [40]):

$$\Delta y_t = \phi y_{t-1} + \sum_{j=1}^{p-1} \alpha_j^* \Delta y_{t-j} + u_t \tag{9}$$

where $\phi = -\alpha(1)$ and $\alpha_j^* = -\left(\alpha_{j+1} + \ldots + \alpha_p\right)$. The hypotheses will be $H_0 : \phi = 0$ versus $H_1 : \phi < 0$. The ADF has the t-statistic of the coefficient ϕ based on the OLS estimation on equation (9). The rejection of the null hypothesis indicates no unit-root problem or the series is stationary.

B. Cointegration Tests

Consider a cointegrating equation in the following representation:

$$y_t = X_t^{'} \beta + D_{1t}^{'} \gamma_1 + u_{1t} \tag{10}$$

With $D_t = \left(D_{1t}^{'}, D_{2t}^{'}\right)'$ as deterministic trend regressors. The *n* stochastic regressors of X_t are obtained from the system equation as below:

$$\begin{aligned} X_t &= \Gamma_{21}^{'} D_{1t} + \Gamma_{22}^{'} D_{2t} + \varepsilon_{2t} \\ \Delta\varepsilon_{2t} &= u_{2t} \end{aligned} \tag{11}$$

The innovations $u_t = \left(u_{1t}, u_{2t}\right)'$ are assumed to be strictly stationary with mean zero, contemporaneous covariance matrix Σ, one-sided long-run covariance matrix Λ and nonsingular long-run covariance matrix Ω as in [41].

$$\Sigma = E\left(u_t u_t^{'}\right) = \begin{bmatrix} \sigma_{11} & \sigma_{12} \\ \sigma_{21} & \sigma_{22} \end{bmatrix}$$

$$\Lambda = \sum_{j=0}^{\infty} E\left(u_t u_{t-j}^{'}\right) = \begin{bmatrix} \lambda_{11} & \lambda_{12} \\ \lambda_{21} & \lambda_{22} \end{bmatrix}$$

$$\Omega = \sum_{j=-\infty}^{\infty} E\left(u_t u_{t-j}^{'}\right) = \begin{bmatrix} w_{11} & w_{12} \\ w_{21} & w_{22} \end{bmatrix} = \Lambda + \Lambda' - \Sigma$$

Both Engle-Granger and Phillips-Quliaris are tests based on the residuals obtained through OLS estimation of equation (10). The Engle-Granger test has the regression on the p-lag augmented Dicky Fuller equation:

$$\Delta\hat{u}_{1t} = (\rho - 1)\hat{u}_{1t-1} + \sum_{j=1}^{p} \delta_j \Delta\hat{u}_{1t-j} + v_t \tag{12}$$

The two test statistics are:

$$\hat{\tau} = \frac{\hat{\rho} - 1}{se(\hat{\rho})}$$

and

$$\hat{z} = \frac{T(\hat{\rho} - 1)}{\left(1 - \sum_j \hat{\delta}_j\right)}$$

where $se(\hat{\rho}) = \hat{s}_v \left(\sum_t \hat{u}_{1t-1}^2\right)^{-1/2}$ is the standard error for $\hat{\rho}$ as in [42]. The null hypothesis is the series are not cointegrated. The rejection of the null hypothesis will reveal the existence of cointegrating relationship.

On the other hand, the Phillips-Quliaris test is based on the following unaugmented Dickey-Fuller regression:

$$\Delta\hat{u}_{1t} = (\rho - 1)\hat{u}_{1t-1} + w_t \quad (13)$$

The estimated results are used to compute the long-run variance of w_{ϖ}. The test statistics are corresponding to the test statistics of Engle-Granger test:

$$\hat{\tau} = \frac{\hat{\rho}^* - 1}{se(\hat{\rho}^*)}$$

And

$$\hat{z} = T(\hat{\rho}^* - 1)$$

where

$$se(\hat{\rho}^*) = \hat{w}_{\varpi}^{1/2}\left(\sum_t \hat{u}_{1t-1}^2\right)^{-1/2}$$

See the manual of Eviews 8 for details.

C. Estimation Approaches

A linear combination of two or more series that are I (1) will give stationary or I(0) series which we termed it as cointegrated. The linear combination that reveals cointegaring relationship will characterize the long-run relationship between variables as in [43]. If no cointegrating relationship is revealed, we will proceed with the estimation using Ordinary Least Square (OLS) approach where all variables are stationary variables in first differencing. In case cointegrating relationship is detected, we will proceed with the estimation using Fully Modified OLS or FMOLS as OLS ignores the long run information. FMOLS estimator is asymptotically unbiased. This method corrects for the problems due to the long run correlation between the cointegrating equation and the stochastic regressors innovations. Let $\hat{u}_{1t}$ be the residuals from estimating equation (10). Then $\hat{u}_{2t} = \Delta\hat{\varepsilon}_{2t}$ can be obtained via regressing the following equation:

$$\Delta X_t = \hat{\Gamma}_{21}^{'}\Delta D_{1t} + \hat{\Gamma}_{22}^{'}\Delta D_{2t} + \hat{u}_{2t} \quad (14)$$

From $\hat{u}_t = (\hat{u}_{1t}, \hat{u}_{2t})'$, we can compute $\hat{\Omega}$ and $\hat{\Lambda}$ which are used to define the modified data:

$$y_t^* = y_t - \hat{w}_{12}\,\hat{\Omega}_{22}^{-1}\hat{u}_2 \quad (15)$$

The biased correction term is computed as:

$$\hat{\lambda}_{12}^* = \hat{\lambda}_{12} - \hat{w}_{12}\hat{\Omega}_{22}^{-1}\hat{\Lambda}_{22} \quad (16)$$

Whereas the estimator of FMOLS is given by:

$$\hat{\theta} = \begin{bmatrix}\hat{\beta}\\ \hat{\gamma}_1\end{bmatrix} = \left(\sum_{t=1}^{T} Z_t Z_t^{'}\right)^{-1}\left(\sum_{t=1}^{T} Z_t y_t^* - T\begin{bmatrix}\lambda_{12}^{*'}\\ 0\end{bmatrix}\right)$$

with

$$Z_t = \left(X_t^{'}, D_t^{'}\right)'.$$

V. Result

Before conducting the estimation, the ADF unit-root test and cointegration tests are conducted to check the property of data. Table II summarizes the results of unit-root test. As observed, all variables are not significant at level, indicating the existence of unit-root at level. All variables become stationary after the first differencing process as the test statistics are significant at 1% level for all variables in first differenced. Since the variables are not stationary at level, applying these variables in OLS estimation may generate spurious results and gives incorrect conclusion. Therefore, these variables should be transformed into stationary form via first differencing before entering the OLS estimation. However, the next consideration is if the variables are cointegrated or have long run relationship. If the cointegrating relationship is revealed, one should consider other approach for estimation such as using error correction model that considers for the long run information. OLS does not consider for long run relationship. Therefore, estimating the model with OLS when there is a cointegrating relationship may ignore the important information which is not efficient. Due to this reason, cointegration tests are conducted to detect the long run relationship among variables.

TABLE II. ADF Unit-Root Tests

Variable	Test statistics	
	Level	First differenced
Y*_china	-1.6235	-4.1782**
Y*_eu	-1.6837	-4.3837**
Y*_jap	-2.0461	-6.5429***
Y_mal	-0.2950	-5.2621***
Y*_sp	-2.8657	-5.0022***
Y*_us	-1.2099	-4.3641**
RER	-1.4412	-4.1928**
RER	-2.3542	-4.5861***

Note: the test is specified with a constant and trend with Newey-West Bandwidth length selection
** indicates significant at 5% level and *** as significant at 1% level

Two cointegration tests are conducted, namely the Engle-Granger and Phillips-Quliaris tests. The tests are conducted for five different models which involve the bilateral trades between Malaysia and five main trading partners respectively. The results of the tests are reported in Table III. On overall, the results detect only one cointegrating relationship case, i.e. in the second model which involves the bilateral trade between Malaysia and EU countries. Therefore, model 2 will be estimated using FMOLS while in the other cases with no cointegrating relationship detected, OLS will be applied. The results of estimations are reported in Table IV.

TABLE III. COINTEGRATION TESTS

Model	Variable	Test	Value	Probability	Remarks
1	TB, Y_mal Y*_china, RER	A B C D	-2.2599 -9.5918 -2.7431 -14.6140	0.7867 0.7610 0.5743 0.4207	No cointegrating Relationship, use OLS
2	TB, Y_mal Y*_eu, RER	A B C D	-4.5227 -22.0464 -4.5215 -21.0393	0.0598* 0.0452** 0.0600* 0.0642*	Detect cointegrating relationship, use FMOLS
3	TB, Y_mal Y*_jap, RER	A B C D	-2.3158 -9.4854 -2.7064 -13.6119	0.7652 0.7676 0.5918 0.4871	No cointegrating Relationship, use OLS
4	TB, Y_mal Y*_sp, RER	A B C D	-3.6498 -18.0992 -3.5841 -16.6836	0.3428 0.3948 0.3700 0.4841	No cointegrating Relationship, use OLS
5	TB, Y_mal Y*_us, RER	A B C D	-4.3133 -34.4487 -2.1517 -6.9713	0.1388 0.0038*** 0.9276 0.9700	No cointegrating Relationship, use OLS

Note: * indicates significant at 10% level; ** as significant at 5% level and *** as significant at 1% level

Test statistic A: Engle-Granger tau-stat; Test statistic B: Engle-Granger z-stat; Test statistic C: Phillips-Quliaris tau-stat;Test statistic D: Phillips-Quliaris z-stat

TABLE IV. RESULTS OF ESTIMATION

Bilateral trade	Method	Variable	Coefficient	Probability
Mal - China	ΔOLS	Constant	-0.07486	0.0514*
		Y_mal	-0.3153	0.2554
		Y*_china	0.8456	0.0052***
		RER	-0.2899	0.3300
		R-square	0.2939	
Mal – EU	FMOLS	Constant	4.5386	0.0060***
		Y_mal	0.0666	0.3063
		Y*_eu	-0.1332	0.6015
		RER	-0.8645	0.0000***
		R-square	0.8527	
Mal – Japan	ΔOLS	Constant	0.0058	0.7920
		Y_mal	-0.1345	0.6897
		Y*_jap	-0.1852	0.4598
		RER	-0.2704	0.3617
		R-square	0.1221	
Mal – Singapore	ΔOLS	Constant	0.0160	0.3886
		Y_mal	-0.0554	0.8665
		Y*_sp	-0.2797	0.1719
		RER	-0.3140	0.2803
		R-square	0.1576	
Mal – U.S.	ΔOLS	Constant	0.0143	0.4492
		Y_mal	-0.5532	0.0678*
		Y*_us	0.9255	0.0081***
		RER	-0.1628	0.4418
		R-square	0.2439	

Note: Δ denotes the first differencing operator.
* indicates significant at 10% level; ** as significant at 5% level and *** as significant at 1% level

From the results obtained, it is observed that the coefficient of RER is negative and not significant in all cases with the exception in the case of Malaysia–EU which is significant at 1% level. In order for Marshall-Lerner condition to be hold, the coefficient of RER should be positive, i.e. devaluation in real exchange rate leads to improvement in trade balance. In all cases, none of the coefficient of RER is positive. The results fail to detect the validity of Marshall-Lerner condition in bilateral trades between Malaysia and main trading partners.

The income levels of trading partners can have impact on the trade balance of domestic country. In the bilateral trade of Malaysia-China and Malaysia–U.S., it is observed that the increase in the income level of China and U.S. lead to significantly increase in the trade balance of Malaysia. This phenomenon can be explained by higher purchasing power of foreign households, hence higher demand of foreign households on the products of Malaysia which leads to higher export of Malaysia. On the other hand, the increase in the income of domestic country seems to have no significant impact on improving the domestic trade balance.

VI. CONCLUSION

In this paper, we seek to test if the Marshall-Lerner condition holds in the bilateral trades between Malaysia and its main trading partners. In particular, we seek to investigate if devaluation in the real exchange rate leads to improvement in the trade balance of domestic country. Applying cointegration tests, the results detect only one cointegrating relationship in the trade of Malaysia–EU. We then proceed with the estimations. Our estimation results fail to reveal the validity of Marshall-Lerner condition in all five pairs of bilateral trades. However, it is observed that higher income level of trading partners may lead to improvement in the trade balance of domestic country. Conversely, higher income level of domestic country does not help to improve the trade balance of domestic country.

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