Existence of Export-Import Cointegration:
A Study on Indonesia and Malaysia

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Abstract

This paper studies the long-run relationship between export and import of two Southeast Asian nations, Indonesia and Malaysia covering data of over 45 years from each country including pre and post-financial crisis period in Asia. This paper studied this phenomenon using two widely used tests Engle-Granger and Johansen cointegration tests. Two tests fail to find cointegration in Indonesia but found this in the Malaysian economy. The meaningfulness of Malaysian export-import cointegration was further tested which did not accept the underlying hypothesis of equal slope coefficients from the equations explaining the phenomenon. The stability tests also found Malaysian economy to be more stable than Indonesian economy.

Keywords: Trade deficits, Intertemporal budget constraint, Cointegration, Vector autoregression

1. Introduction

International trade deficits have been studied by researchers in search for its sustainability. Unsustainable trade deficits mean violation of international budget constraints over time. Due to long-run deficits, domestic interest rates will be excessively high and such an economy, in course of time, will turn into a heavily debt-ridden one resulting in poor standard of living (Baharumshah et al., 2003). So existence of long-run relationship between exports and imports, in other words, cointegration between these two, is desirable to the nations and this phenomenon has been tested empirically many times by researchers to check whether the trade deficits are present only in the short-run or not. Export-import cointegration does indicate that such countries have not violated intertemporal budget constraints due to accurate macroeconomic policies (Husted, 1992;Erbaykal & Karaca,2008). On the contrary, persistent current account deficits pose serious economic problems and require policy intervention (Baharumshah et al., 2003). Similar argument is made by Arize(2002), Irandoust & Ericsson(2004), Choong et al.(2004), Narayan and Narayan, (2004), Narayan and Narayan, (2005). However, Erbaykal & Karaca (2008) argue that for meaningful cointegration, the slope coefficients from the equations derived from export and import data series should be equal to 1.

Husted (1992) studied quarterly US trade data between 1967 and 1989, having adjusted for the structural break in data, and concluded a long-run relationship between U.S. export and import pointing that its trade deficit had been a short-run phenomenon. But Fountas and Wu (1999), however, concluded other wise, studying US trade data ranging between 1967-1994, arguing that US trade deficit was not sustainable. It is worth mentioning that these two studies applied different methods of estimation, namely Engle and Granger (1987) and Stock and Watson (1988) in Husted and Engle-Granger (1987) and Gregory and Hansen (1996) in Fountas and Wu. In their paper Bahmani-Oskooee and Rhee (1997) investigated Korean export and import data applying Johansen and Juselius' (1990) system-based cointegration technique and found trade sustainability. Arize (2002) conducted a more comprehensive study recently, covering 50 countries' quarterly data, and identified long-run relationship between export and import for 35 countries including the United States, Indonesia and Malaysia(latter two are studied in this paper). Like Bahmani-Oskooee et al., Arize used export as the forcing variable and tested the long-run relationship with the Johansen and Juselius' system-based cointegration approach along with two residual-based approaches namely the dynamic OLS (DOLS) introduced by Stock and Watson (1988) and the fully modified OLS (FMOLS) by Phillips and Hansen (1990). In Arize's study, Korea was one of the 35 countries for which long-run relationship was observed. However, the studies of Arize's and Bahamni-Oskooee et al. differed in the estimate of the export coefficient for the Korean data, which can be attributed to the selection of quarterly data of different sample period(over 1963-91 in Bahmani et al. and in Arize covering the period 1973-98). Thus it can be stated that cointegration of international trade, may or may not exist depending on the choice of techniques and sample period and the selection of countries, as may probably be revealed from the deeper review of relevant empirical literature. As a result, researchers have ample scope for studying this phenomenon. Apart from the estimation techniques stated above, trade analysts have also used bound testing

approach to a set of fractionally integrated variables. For instance, Narayan and Narayan (2005) have applied the bound testing to investigate long-run relationship between export and import among 22 least developed countries and did not find cointegration.

This paper studies cointegration between export and import of two ASEAN nations, namely, Indonesia and Malaysia and the choice is mainly due to availability of suitable data. Annual data of export and import in USD(constant 2000) covering years 1960-2008 for Indonesia and 1960-2007 for Malaysia from World Development Indicators (WDI) of the World Bank have been used in this article.

These two countries' similar phenomenon has been studied earlier (Baharumshah et al., 2003; Arize, 2002)) as well, though there were other countries simultaneously studied; but not covering data after 1999, and Keong et al.(2004) studied exclusively Malaysia's external trade balance sustainability between 1959 and 2000. This paper covers more period than being studied by others and can be considered a prospective addition to the existing literature of long-run relationship between export and import of any nation. Baharumshah et al. (2003) found inconclusive result for both the countries having studied different subsets of samples covering annual data between 1961 and 1999 (in 1997 these countries experienced financial crisis along with other regional economies). On the contrary Arize (2002) found cointegration between export and import of both the countries studying quarterly export and import data between 1973 and 1998 along with many other countries (mentioned earlier). These two studies were also different in the methodology being applied to test cointegration. However, Keong et al. (2004) convincingly concluded that Malaysia's export-import relationship did not have disequilibrium in the long-run probably due to successful macroeconomic policy intervention to maintain a stable level of inflation.

Indonesia and Malaysia are two founding members of ASEAN (Association of Southeast Asian Nations) since 1967. This region's countries were featured with relatively high level of saving of more than 30% of GDP (gross domestic product) and substantial amount of investment (44% in Malaysia) for more than couple of decades (Baharumshah et al.,2003).The countries also undertook programs for structural adjustments and exported manufactured outputs increasingly since the 1980s. Attracting huge foreign investments in addition to technology transfers from the developed countries also resulted in rapid economic growth of these two countries along with other founding members of ASEAN (Baharumshah et al., 2003). Both the countries were among the nations experiencing Asian financial crisis of 1997-2000. Like other regional economies, these two used to peg their currencies to US dollar, though huge Japanese investment in this region also made these countries, including their regional partners, vulnerable to yen/dollar exchange rate fluctuations (Kwan, 2001). But, study found that due to the regional currencies' abrupt depreciation against US dollar and yen, current account deficit swung to current account surplus of these countries during Asian financial crisis in the post-crisis period (Baharumshah et al., 2003). However, after several years of Asian financial crisis, Indonesia could not have overcome its bad economic effects until recent time as evident in its unemployment rate and GDP growth (Simorangkir,I. 2006).

This author aims at finding cointegration relationship between exports and imports of these two nations and if cointegration is found, further test would check whether this relationship is meaningful over the sample period with the slope coefficients obtained from the equations derived from these series being equal to 1. Also, stability tests have been employed to check structural stability of both the economies over the sample period.

The paper has four more parts. Next part presents the theoretical framework. Part three describes the methodology. The fourth part sequentially presents the empirical results at each stage along with the pertinent interpretation. The final part concludes.

2. Theoretical Framework

Husted's (1992) simple model of intertemporal budget constraint, showing the theoretical justification of the necessity of testing long relationship between import and export, has been used by the author to test this phenomenon. The model, shown in equation (i), starts with the budget constraint of a representative consumer living in an open economy which produces a single composite exportable, does not have government intervention in economic activity and has access to international capital market.

$$C_0 = Y_0 + B_0 \ - I_0 - (1+r) \ B_{-1} \qquad \qquad (i)$$

where $C_0,\ Y_0,\ B_0,\ I_0$ and $(1+r)\ B_{-1}$ are, respectively, current period consumption, output, international borrowing, investment and the accumulated past debt estimated at current world interest rate, r. Under the relevant assumptions, Husted (1992) derived a test model by formulating hypotheses from the equation (i) as the following:

$$X_t = a + bM_t \ + e_t \qquad \qquad (ii)$$

$$M_t \ = a + bX_t + e_t \qquad \qquad (iii)$$

Equation (iii) is written following Arize (2002) derived from the preceding equation (ii). In the last two equations, X_t, M_t and e represent the measures of export and import of a country and the error terms respectively. According to this model, an economy may maintain intertemporal budget constraint by fulfilling two conditions (Erbaykal & Karaca, 2008).   The economy may have long-run export-import relationship if the model has stationary error terms (e). And more importantly, for a meaningful cointegration between export and import, it is required that b (the slope coefficient) is statistically equal to 1 in addition to the aforesaid condition in the previous line (Erbaykal & Karaca, 2008).   The slope coefficients (if b>1 or b<1) derived from equations (ii) and (iii) indicate how much a country exports (in dollar term) per dollar unit of import and vice versa.

3. Methodology

At the beginning, logarithmic transformation of export and import data series (constant $ 2000) of both Indonesia and Malaysia have been made, as by doing so scale of measurement is compressed.

Before testing for cointegration, series have been checked for stationarity using ADF (Augmented Dickey-Fuller) test which was developed by Dickey and Fuller (1981). Both pairs (each for Indonesia and Malaysia) of log-transformed export and import series have been found to be non-stationary at level with and without trend. After the first difference, these series have become stationary or the series of import and export of both Indonesia and Malaysia are integrated of order 1 or I (1). So, these series can be tested for cointegration.

To analyze the cointegration relationship in this paper, two tests, namely, Engle-Granger method (two-step) and Johansen cointegration test are applied.

Engle and Granger (1987) have developed two-step method to test the cointegration relationship between such series as analyzed in the present paper {I (1)}. There are two steps of the Engle-Granger cointegration test. Firstly, the regression equations variables are formulated as:

$$Y_t = \beta_0 + \beta_1 X_t + {}_t \qquad\qquad (iv)$$

$$Y_t = \beta_0 + \chi t + \beta_1 X_t + {}_t \qquad\qquad (v)$$

The corresponding residual series is calculated as :

$$e_t = Y_t - (\hat{\beta}_0 + \hat{\beta}_1 X_t) \qquad\qquad (vi)$$

where X_t and Y_t are two time series, β_0 is a non-zero drift, β_1 is the coefficient of data series X_t, ${}_t$ is the residual series of regression. The arithmetic product of χ and t denotes a deterministic time trend, $\hat{\beta}_0$ and $\hat{\beta}_1$ are the estimated magnitudes of β_0 and β_1 respectively, t = 1, 2,3,…, n and n is the dimension of the vector variable. Eq. (iv) and (v) are two types of Engle-Granger cointegration test and by nature without deterministic time trend and with deterministic time trend respectively.

Secondly, this procedure tests the stationarity of the residuals of the above equations and after derivation the equation takes the following form:

$$\Delta e_t = \alpha + \delta t + \gamma e_{t-1} + \sum_{i=1}^{m} \lambda_i \, \Delta e_{t-i} + {}_t \qquad\qquad (vii)$$

where the symbol α denotes a drift which is not zero, and the product value of δ and t denotes a deterministic time trend, Δe_t is the first difference of the residual series e_t derived from Eq. (vi). The symbol i is the lagged term of each variable and e_{t-i} represents the ith lagged term of the variable match along with e_t. ε_t is the generated residual series of the stationarity test equation, t= 1, 2,3,….., n and n is dimension of the vector variable. The pairwise cointegration relationships exist between the couples of variables if the residual series are found to be stationary at level or integrated of order 0 i.e. I (0). Otherwise the cointegration is nonexistent between the two series, and then the regression equation will be regarded as a spurious regression equation.

Johansen's (1991) cointegration test has been employed to check whether the linear combination of the series possesses a long-run equilibrium relationship or not. For this approach, an unrestricted Vector of Autoregression (VAR) has been estimated that has the following form:

$$\Delta X_t = \alpha + \Gamma_1 \Delta X_{t-1} + \Gamma_2 \Delta X_{t-2} + \ldots + \Gamma_{k-1} \Delta X_{t-k-1} + \Gamma X_{t-k} + u_t \qquad (viii)$$

Where, Δ is the difference operator, X_t is a (n×1) vector of non-stationary variables (on their levels) and u_t is also the (n×1) vector of random errors which is distributed with zero mean and variance matrix δ^2 [$u_t \sim N(0, \delta^2)$] which means that u_t is a white noise disturbance term. Furthermore, $\Gamma_{k-1} = I - [\Pi_1 \ldots \Pi_{k-1}]$ and $\Gamma_k = I - [\Pi_1 \ldots \Pi_k]$, where I stands for identity matrix.

The matrix Γ contains the key information on long-run relationship between the variables. The rank (usually denoted by 'r') of Γ determines the cointegrating vectors of the variables. If the rank of Γ equals zero, then the variables are not cointegrated. Following this decision, the further symptoms will be if rank 'r' is equal to one, then this means

there exists one cointegrating vector and finally, if 1 < r < n, then the conclusion is there are multiple cointegrating vectors.

Following the Johansen procedure, the Trace test and the max-Eigen test are performed in the current paper to calculate the nature of cointegration between Exp and Imp of each country.

This procedure begins with the determination of lag length of the vector autoregressive system using methods such as Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC). For the purpose of this test in the current paper, lag order for Indonesia and Malaysia were 1 and 1 to 2 respectively. Following an unrestricted vector autoregressive (VAR) model, presence of cointegration relationship(s) is determined by Trace statistic and max-Eigen value introduced by Johansen and Juselius (1990).

Author also checked the hypothesis that whether the slope coefficients of the equations (ii) and (iii) were exactly equal to 1 or not, necessary for cointegration to be meaningful, between export and import of the economies studied in this paper. In this regard, the Wald tests were conducted. Structural stability of both economies were also studied using the 'Recursive least square' estimation.

4. Empirical Results & Interpretation

Export and import data series of both Indonesia and Malaysia had logarithmic transformation before estimation to compress the scale of measurement. Thereafter, ADF tests to check the presence of unit root, in both pairs of export and import data were done. The results are shown in Table 1.

The table suggests that both pairs of series were nonstationary at level and became stationary at the first difference, hence, appropriate for testing cointegration between the series.

To check for cointegration between export and import of each of the studied economies, the author first used the two-step Engle-Granger method, as mentioned earlier. In this method, the assumed cointegration equation is estimated using OLS (ordinary least square) and the residuals from the estimation are saved. According to Engle and Granger (1987), the variables would be cointegrated if the residuals saved from the equations are found to be stationary following ADF (augmented Dickey-Fuller) unit root test. But in this regard special critical values (MacKinnon,2010) were used, as ADF critical values were not reliable. As Table-3 also suggests, using this method, cointegration was found between import and export of Malaysia but for Indonesia such relationship could not be found.

To further check cointegrating relationship between the pairs of import and export data series, Johansen procedure(1991) in an unrestricted VAR (vector autoregression) framework was used. This procedure requires the selection of the appropriate lag length of vector autoregressive system and in this article, following AIC and SIC methods the lag lengths for Indonesia and Malaysia were 1 and 1 to 2 respectively.

The Johansen procedure also points to cointegration between Malaysian export and import and lack of such relationship in Indonesia as evident in the Trace test and max-Eigen statistics in Table-4.

From the analysis done so far, it is evident from both methods of cointegration that Indonesia violates intertemporal budget constraint, i.e., no cointegration between export and import; whereas, Malaysian export and import are cointegrated over the sample period.

As mentioned earlier, to check the meaningfulness of the cointegration (Erbaykal & Karaca, 2008), Wald test is used to check whether slope coefficients of the estimated equations equal to exactly 1 or not.

Checking with the F-distribution table (Anderson et. Al., 2008) the F-statistics are found to be greater than the respective critical values for both equations. Also the coefficients from the estimated equations are found not to be exactly 1(but close to 1) from the estimation. Thus, the hypothesis of slope coefficient equals to 1 can be rejected, indicating that Malaysian export-import cointegration may not be meaningful.

From the recursive least square estimation for checking structural stability of Indonesian and Malaysian economies, the finding is suggestive of stability in Malaysia, as evident from the corresponding figures(1 to 3) of CUSUM (cumulative sum) test, Recursive residuals and CUSUM of Squares test. In both outputs of CUSUM and CUSUM of Squares (see figure) the residuals do not cross pairs of 5% critical lines, indicating stability and parameter constancy in the estimated equation. However, recursive residuals being plotted within +/- 2 standard error (S.E) bands do exhibit instability in the parameters of equation in 1974 and 1980. But it can be concluded from this stability test on Malaysia that the parameters of the estimated equation were almost constant over the sample period.

Studying the recursive least square estimation of Indonesian data (figures 4 to 6), it seems that it had more structural instability which may further support findings from cointegration tests. The recursive residuals and CUSUM of Squares reveal this instability between periods of 1980 to 1982 and 1973 to 1982 respectively.

5. Conclusion

This paper found export and import to have relationship in the long-run for Malaysian economy but similar relationship was not detected in case of Indonesia. Though both the countries fell victim to 1997-Asian financial crisis, in terms of sustainability of current account deficits Malaysia's performance was better than Indonesia. Considering only one test for checking stationarity (ADF test) of data by this author may be a limitation of this paper, but since both Engle-Granger two-step approach and Johansen's cointegration had similar findings in this study, it can be said to have little effect on estimation. Though Malaysia's export-import cointegration was detected, the Wald test showed that it did not have meaningful cointegration as slope coefficients of both the equations expressing the relationship between export and import were not equal to 1. The recursive residual test found parameter non-constancy only in two years (1970 and 1984) in the total studied period of 48 years in Malaysia. And in Indonesia the CUSUM of Squares reveals more instability during the observed period but other two tests suggest more or less constancy of parameter over the sample period. As far as the analysis presented here is concerned, Malaysia seems to have better managed its trade deficits over the years than Indonesia.

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Table 1. Unit root test results

Series	t_a	t_b
At level		
LX1	-0.021270	-2.017600
LM1	-0.917566	-1.473325
LX2	0.944802	-2.212376
LM2	0.498061	-2.426189
1st difference		
LX1	-6.677732	-6.643638
LM1	-6.112498	-6.032603
LX2	-6.163788	-6.255063
LM2	-5.805052	-5.814598

1 and 2 represent data series from Indonesia and Malaysia respectively. LX and LM are the log transformed export and import series of the respective nations. t_a and t_b indicate ADF test statistics without trend and with trend respectively. At 1st difference the values were significant at 10%.

Table 2. Engle-Granger cointegration test summary

Variable[***]	Coefficient	Std Error	t-stat	p-value
C1	9.315320	0.542388	17.17464	0.0000
LM1	0.628111	0.022953	27.36561	0.0000
C2	0.348727	0.305516	1.141436	0.2596
LM2	0.990536	0.012917	76.68216	0.0000

[***]1 and 2 represent results from Indonesia and Malaysia, respectively.

Table 3. ADF of Residual

Variables	Without Trend ADF	Decision	Order of Integration
Residual 1[*]	-1.373758	Non-stationary	I(1)
Residual 2[*]	-3.327032	Stationary	I(0)

[*]Mackinnon critical value (2010) at 5% significance level: -1.947422(no constant) and -2.9214588(no trend) for the number of observations the four countries' data series had.

Table 4. Johansen cointegration test result (unrestricted constant)

Rank[*]	Eigenvalue	Trace Stat	p-value	Max-Eigen Stat	p-value
0(1)	4.971864	4.976371	0.8113	4.971864	0.7454
1(1)	0.004506	0.004506	0.9456	0.004506	0.9456
0(1to2)	0.298655	25.33539	0.0091	15.96397	0.0487
1(1to2)	0.187999	9.371429	0.0457	9.371429	0.0457

[*]O and 1 represent number of cointegrating equation(s). And the numbers in the parentheses indicate lag length of autoregressive system.

Table 5. Results of the Wald tests for Malaysia

Equation[*]	Coefficient b	Null Hypothesis	F Statistics
LX2	0.990536	$H_0 : b=1$	4.544198
LM2	1.001718	$H_0 : b=1$	14.09324

[*]LX2 and LM2 represent export and import data series of Malaysia respectively.

MALAYSIA
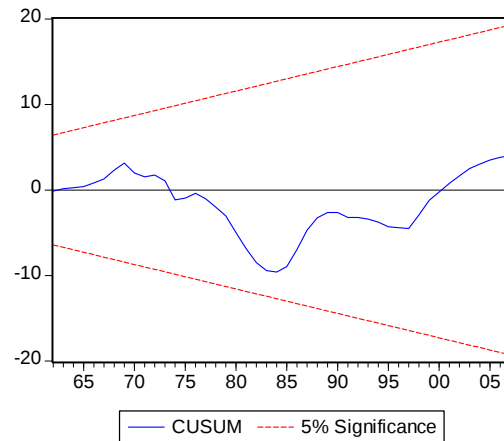
Figure 1.

Figure 2.

Figure 3.

INDONESIA
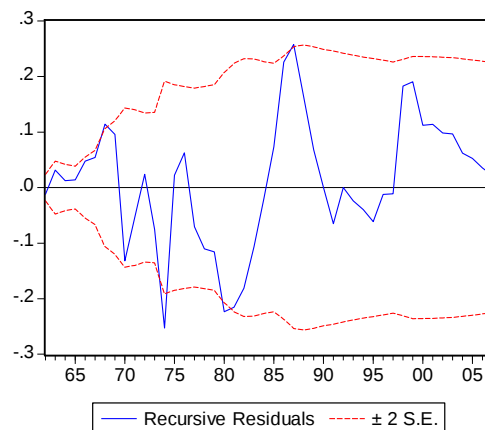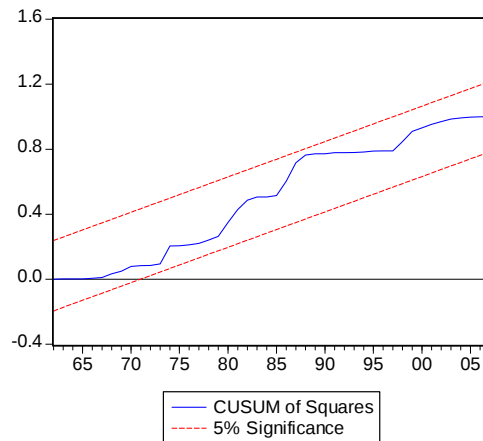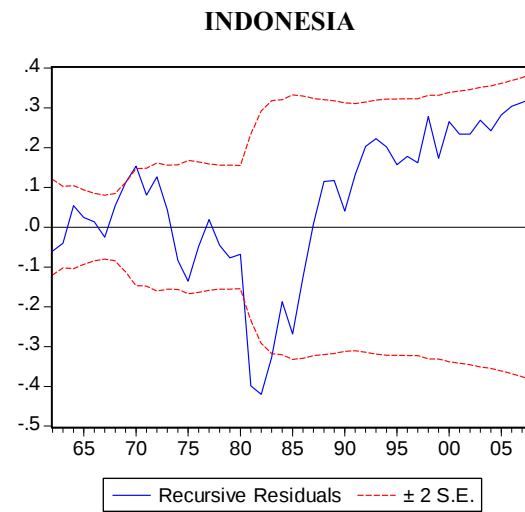
Figure 4.

Figure 5.

Figure 6.