(Research note)

The Effects of Exchange Rate on Trade Balance in Vietnam: Evidence from Cointegration Analysis

LE, Thuan Dong*
ISHIDA, Miki †

Abstract

There has been many researchers studied the effects of exchange rate on trade balance in Vietnam, when it's real exchange rate began appreciating in 2003. However, empirical studies examining the relationship between exchange rate and trade balance are limited. Most studies focus on only the long-run relationship; the short-run effect of exchange rate on trade balance has not been properly explored. This paper aims to fill this gap by measuring the effects of exchange rate on trade balance in the long run and short run, applying the autoregressive distributed lag model (ARDL) bound testing approach to cointegration with an error correction model (ECM) to explore the long-run and short-run relationships. The empirical analysis shows that there is evidence of J-curve only in Japan, Malaysia and Thailand models, and Marshall-Lerner condition holds in both aggregate model and disaggregate models except Singapore model.

Key words: trade balance, exchange rate, ARDL method, and error correction model.

* Doctoral Course Student, Graduate School of International Development & Cooperation, Hiroshima University. D153435@hiroshima-u.ac.jp
† Professor, Graduate School of Social Sciences, Hiroshima University. mishida@hiroshima-u.ac.jp

1. Introduction

This paper tries to contribute to the growing literature on the effects of real exchange rate on trade balance, J-curve and Marshall-Lerner condition for seven selected trading partners using cointegration analysis. It explores whether real exchange rate depreciation improve trade balance. This issue is resolved in theory in the sense that if Marshall-Lerner condition holds an improvement in the trade balance would occur. Nevertheless, it is still an open empirical subject because this condition does not hold in some countries across time. Moreover, even when the condition holds and improvement occurs, it may be that at the beginning trade balance deteriorates before it subsequently improves. This pattern is known as the J-curve effect. This theory also depends on the empirical evidence to support or reject it.

Differ from previous studies, this current paper uses both aggregate and disaggregate data for the period 1990 to 2013, and applies structural break unit root tests to get less biased results.

2. Literature Review

Several studies have examined the effects of real exchange rate on trade balance. Emmanuel and Ronald (2014) show that there is cointegration between the trade balance and the real effective exchange rate, and domestic and foreign income. The real effective exchange rate, however, has no impact on trade balance in the long-run. They also demonstrate that there is lack of evidence of the J-curve for South Africa. Rose (1990) examines the impact of real depreciation on the trade balance for 30 developing countries and finds lack of evidence that real depreciation would lead to an improved trade balance for Argentina, Brazil, Chile, Colombia, Peru and Uruguay.

Tihomir (2004) shows the existence of the J-curve in Croatia and in an economy similar to the Serbian one, since both shared 70 years of common economic history within former Yugoslavia. The ARDL approach is used employing quarterly data. In the long run, real depreciation improves the trade balance.

3. Data and Methodology

Annual time series data on exchange rate, gross domestic product, relative prices, exports and imports, which cover the 1990-2013 period, were used in this paper. The data for exchange rate and relative prices were taken from *International Financial Statistics*, a publication of the International Monetary Fund. Exports to and imports from Vietnam's trading partner countries including Japan (JP), Singapore (SG), the United State (US), China (CN), Malaysia (MY), South Korea (KR) and Thailand (TL) were collected from *Direction of Trade Statistics*, also published by the International Monetary Fund. Nominal income in Vietnam and its trading partner were taken from *World Economic Outlook Database*, also published by the International Monetary Fund.

For the dependent variable, trade balance denoted by *TB* is measured by the log of exports divided by imports. For independent variables, real income in home country denoted by *YD* is represented as Vietnam's real GDP; real income in its trading partner countries denoted by *YF* is represented as GDP of Vietnam's trading partner countries; real exchange rate denoted by *RE* is bilateral real exchange rate for disaggregate models, measured by the nominal exchange rate divided by the price in the home country, and is the real effective exchange rate for aggregate model, measured by weighted average of bilateral real exchange rates with trading partner countries.

Following Rose and Yellen (1989), the trade balance can be expressed as:

$$TB=TB(RE,YD,YF), \tag{1}$$

where

TB = the trade balance defined as the ratio of exports / imports,

YD = real income in home country, and

YF = real income in trading partner countries.

To measure the elasticity of the trade balance with respect to the real exchange rate, real income in Vietnam and real income in its trading partner countries, equation (1) can be expressed as a logarithm equation:

$$LnTB_{it}=\alpha_1+\alpha_2 LnYD_t+\alpha_3 LnYF_{it}+\alpha_4 LnRE_{it}, \tag{2}$$

where α_2, α_3 measure the elasticity of trade balance with respect to real income in the home country and trading partner countries, α_4 represents the elasticity of trade balance with respect to the real exchange rate, showing whether Marshall-Lerner condition is satisfied or not. Marshall-Lerner condition holds whenever α_4 is positive, indicating that a real depreciation improve the trade balance over time.

Although several traditional econometric methods have been proposed to investigate the existence of long-run relationships among variables, including the methods developed by Engle and Granger (1987), Phillips and Hansen (1990), and Johansen (1988), this study uses the ARDL cointegration technique developed in Pesaran and Shin (1999) and Pesaran et al. (2001) to achieve its objective. It has certain advantages in comparison with conventional cointegration methods.

First, this approach can be applied without considering the fact that regressors are integrated of order zero or order one. More specifically, this method does not require that all variables in a time series regression equation must be integrated of the same order. They can be integrated of order zero, order one or fractionally integrated. Second, it is relatively more appropriate for the small and finitely sized datasets. Third, we can obtain unbiased estimates of the long-run model. Lastly, it deals with the endogeneity problems due to adding lagged dependent variable. The ARDL (p, q, r, s) model used in this study is expressed as follows:

$$\begin{aligned}\Delta LnTB_{it}=&\beta_i+\gamma_{i1} LnTB_{it-1}+\gamma_{i2} LnYD_{it-1}+\gamma_{i3} LnYF_{it-1}+\gamma_{i4} LnRE_{it-1}\\&+\textstyle\sum_{j=1}^{p-1}\theta_{i1j}\,\Delta LnTB_{it\text{-}j}+\sum_{j=0}^{q-1}\theta_{i2j}\,\Delta LnYD_{it\text{-}j}+\sum_{j=0}^{r-1}\theta_{i3j}\,\Delta LnYF_{it\text{-}j}\\&+\textstyle\sum_{j=0}^{s-1}\theta_{i4j}\,\Delta LnRE_{it\text{-}j}+\sum \pi_{ij}B_{itj}\,\varepsilon_{it,}\end{aligned} \tag{3}$$

where Ln(.) is the logarithm operator; β is the drift component; Δ is the first difference; θ_{i1j}, θ_{i2j}, θ_{i3j}, and θ_{i4j} are the short-run effects of variables in the model; while γ_{i1}, γ_{i2}, γ_{i3}, and γ_{i4} are the long-run elasticities; π_{ij} is the elasticity of break year dummy variables; and ε_t is the white noise error term. The null hypothesis is that the coefficients of lagged regressors in levels in the underlying ARDL model are jointly equal to zero. The hypothesis is defined by $H0$: $\gamma_{i1}=\gamma_{i2}=\gamma_{i3}=\gamma_{i4}=0$ and it is tested against the alternative hypothesis that $H1$: $\gamma_{i1}\neq0$, $\gamma_{i2}\neq0$, $\gamma_{i3}\neq0$, $\gamma_{i4}\neq0$.

The ARDL approach to cointegration uses the F-test to find the presence of long-run relationships among variables, although the asymptotic distribution of the F-statistic in this context is not standardized without taking account of whether the variables are integrated of order zero or order one. The critical values of the distribution are shown in Pesaran and Pesaran (1997) and Pesaran et al. (2001). Two sets of values are represented in the form of a table. The first set is the upper bound critical value assuming that all variables are first-order integrated, while the second set is the lower bound critical value assuming that all variables are zero-order integrated. If the value of the calculated F-statistic is higher than the upper bound, the null hypothesis is rejected, thus indicating the presence of long-run relationships among variables. On the other hand, if the value of F-statistic is below the lower bound, the null hypothesis cannot be rejected. In the case where the F-statistic lies within the region between lower and upper bounds, the result is indeterminate.

If long-run relationships among variables exist, the error correction representation also comes into play. Therefore, in order to analyze the short-run relationships among variables, we apply ECM. It indicates that the speed of adjustment of dependent variables toward a new long-run equilibrium in the future after a short-run shock in the independent. A general error correction representation of Equation (3) is formulated as follows:

$$\begin{aligned}\Delta LnTB_{it} = {} & \beta_i + \sum_{j=1}^{p-1}\theta_{i1j}\,\Delta LnTB_{it-j} + \sum_{j=0}^{q-1}\theta_{i2j}\,\Delta LnYD_{it-j} + \sum_{j=0}^{r-1}\theta_{i3j}\,\Delta LnYF_{it-j} \\ & + \sum_{j=0}^{s-1}\theta_{i4j}\,\Delta LnRE_{it-j} + \sum \delta_{ij}\Delta B_{itj} + \lambda_i ECT_{it-1} + \eta_{it},\end{aligned} \tag{4}$$

where λ_i is the speed of adjustment parameter and is expected to be negative; and ECM is the residual derived from the estimation of the long-run model. The magnitude of this coefficient implies that nearly ($-\lambda_i$*100) percent of any disequilibrium is corrected in the next ($-12/\lambda_i$) months.

4. Unit Root Tests

Before running the ARDL bounds test, we first test for the satationarity for all variables in the models to determine the order of integration for each. The objective is to ensure that no variables are integrated of over order two and to avoid spurious results.

The commonly used methods to test for the presence of unit roots are the Augmented Dickey-Fuller (ADF) test. In the following equation, we test the null hypothesis of α=0 again the alternative hypothesis α<0:

$$\Delta y_t = u + \beta t + \alpha y_{t-1} + \sum_{i=1}^{k} c_i \Delta y_{t-1} + \varepsilon_t \tag{5}$$

where Δ denotes the first difference, y_t is the time series being tested, t is the time trend variable, and k is the number of lags which are added to the model to ensure that the residuals, ε_t have zero mean and constant variance. In this study, Schwarz Bayesian Criterion (SBC) is used to determine the optimal lag length k. Non-rejection of the null hypothesis implies that the series is non-stationary; whereas the rejection of the null indicates the time series is stationary. The results of ADF unit root tests are represented in Table 1.

Table 1: Results of Unit Root Tests

	ROW	JP	SG	US	CN	MY	KR	TL
LnTB	-2.235	-1.539	**-3.336****	**-3.599****	-1.381	**-3.861*****	**-2.724***	**-5.571*****
Δ*LnTB*	**-4.223****	**-6.887*****	---	---	**-8.328*****	---	---	---
LnYD	-1.081	-1.081	-1.081	-1.081	-1.081	-1.081	-1.081	-1.081
Δ*LnYD*	**-2.742***	**-2.742***	**-2.742***	**-2.742***	**-2.742***	**-2.742***	**-2.742***	**-2.742***
LnYF	0.813	-2.132	-0.301	-0.976	1.523	-0.212	-0.776	-0.304
Δ*LnYF*	**-3.826*****	**-3.424****	**-3.145****	**-3.587****	**-5.220****	**-4.285*****	**-4.229*****	**-3.096****
LnRE	0.214	-0.156	**-3.595****	-1.723	**-4.230*****	**-3.704****	-1.584	**-5.333*****
Δ*LnRE*	**-4.442*****	**-2.861***	---	**-3.187****	---	---	-4.064***	---

Notes: ***, **, and * represent statistical significance at the 1%, 5%, and 10% level, respectively. The number inside the parenthesis is the value of t-statistics.

Based on the results, it can be concluded that some variables are stationary at level while some variables have unit roots at level and stationary at first difference. Therefore, variables in the models are pure of I(1) or mixes of I(0) and I(1).

Structural break often occurs in many times series for any numbers of reasons, changes in institutional arrangements, policy changes and regime shifts. An associated problem is testing of the null hypothesis of structural stability against the alternative of a single exogenous structural break. According to Perron (1989) and Perron (1997), if such structural changes are present in the data generating process, but not allowed for in the specification of an econometric model, results may be biased towards the erroneous non-rejection of the non-stationarity hypothesis. However, Perron's assumption of the break date was criticized, notably by Christiano (1992) as data mining. Christiano argues that the data based procedures are typically used to determine the most likely location of the break and this approach invalidates the distribution theory underlying conventional testing.

Several studies have developed using different methodologies for endogenously determining the break dates. Some of these include Perron and Vogelsang (1992), Banerjee, et al. (1992). These endogenous break tests allow for the possibility of one or multiple breaks, and can reduce bias in the usual unit root tests. Table 2 indicates unit roots tests with structural breaks to determine the break year dummy variables.

Table 2: Break Year Dummy Variables

Break year	ROW	JP	SG	US	CN	MY	KR	TH
B1	2000	2000	2000	1994	None	2003	2003	None
B2	2007	2008	2008	2005	None	None	2008	None

Notes: B1 and B2 take 0 value for the years before break year and take 1 value for others.

5. Empirical Results

Once the orders of integration of variables retained in the model are either zero or one, we can confidently apply the ARDL bounds test to the model. We now apply the cointegration test developed by Pesaran et al. (2001) to determine the existence of long-run relationships among the variables. Table 3 presents the bound test based on Akaike Information Criteria and diagnostic tests. As shown, the null hypothesis that there is no cointegration relationship both aggregate model and disaggregate models can be rejected indicating there are long run relationship among variables.

Table 3: Results of Bounds Tests and Diagnostic Tests

Partner	Lag	Case	F-Statistics	Outcome	S	H	R	C	C^2
ROW	2	II	**4.406******	Cointegration	0.840	0.809	0.011	Pass	Pass
JP	2	I	**8.510******	Cointegration	0.495	0.885	0.755	Pass	Pass
SG	2	I	**7.021******	Cointegration	0.161	0.354	0.913	Pass	Pass
US	2	II	**70.112******	Cointegration	0.596	0.962	0.123	Pass	Pass
CN	2	IV	**9.912******	Cointegration	0.766	0.819	0.363	Pass	Pass
MY	2	II	**3.843******	Cointegration	0.037	0.794	0.138	Pass	Pass
KR	2	II	**9.898******	Cointegration	0.122	0.514	0.105	Pass	Pass
TL	2	IV	**5.882******	Cointegration	0.234	0.290	0.569	Pass	Pass

Notes: S, H, R, C, C^2 are Serial Correlation test, Heteroskedasticity test, Ramsey RESET test, CUSUM test and CUSUM SQ test, respectively. Case I: no intercept and no trend, Case II: restricted intercept and no trend, Case III: restricted intercept and no trend, Case IV: unrestricted intercept and restricted trend.

To determine the performance and/or adequacy of the ARDL model, diagnostic tests are conducted. We use a residual test in the form of the auto-correlation large range multiplier test. The existence of auto-correlation in the model residuals would lead to an inefficient model. The objective is to ensure that all variables displaying autocorrelation in the model must be rejected. In addition, it is determined that a model does not a serial correlation when the *p* value higher than the level of significance and thus there is no strong evidence to reject the null hypothesis. Moreover, relevant tests including the heteskedasticity and Ramsey RESET test need to be conducted. All the results of these tests are shown in right hand side of Table 3. And to test model stability, we apply the cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMSQ) tests proposed by Brown et al. (1975). The CUSUM test uses the cumulative sum of recursive residuals based on the first n observations, which is recursively updated and plotted against the breakpoint. The CUSUMSQ test uses the recursive residuals squared and follows the same procedure. If the plots of the CUSUM and CUSUMSQ remain within the critical limits of the 5 percent significance level, the null hypothesis that all the coefficients are stable cannot be rejected. Aggregate model does not pass only the Ramsey RESET test while disaggregate models pass all of diagnostic tests.

Table 4: The Estimated long-run models results.

	ROW (2,0,2,1)	JP (1,2,2,2)	SG (1,2,2,2)	US (2,0,0,0)	CN (1,0,2,1)	MY (2,2,2,2)	KR (2,1,2,2)	TL (2,2,2,2)
Constant	-14.07*** [-10.023]			-15.29*** [-5.030]		-12.79*** [-4.347]	-10.30*** [-5.838]	
Trend					-0.075*** [-3.245]			-0.238** [-2.698]
LnYD	-1.442*** [-11.081]	2.001* [2.145]	0.377 [0.422]	1.821 [1.454]	3.443** [2.198]	6.065** [3.529]	3.516** [3.095]	13.14*** [3.784]
LnYF	3.748*** [10.258]	-3.086** [-2.289]	-0.780 [-0.657]	-0.276 [-0.130]	-1.997* [-1.829]	-6.057** [-3.163]	-3.321** [-2.467]	-10.63*** [-4.247]
LnE	0.209*** [3.866]	3.895** [2.412]	0.318 [0.641]	5.557*** [3.237]	4.237** [2.841]	7.584*** [4.352]	6.272*** [4.833]	14.73*** [5.055]
B1	-0.044** [-2.636]	-0.279** [-2.730]	-0.150 [-1.590]	1.903*** [22.122]		-0.378** [-3.048]	-0.123* [-1.866]	
B2	-0.056** [-2.877]	0.128 [1.493]	0.196* [2.123]	0.351*** [3.977]			0.523*** [6.720]	

Notes: ***, **, and * represent statistical significance at the 1%, 5%, and 10% level, respectively. The number inside the parenthesis is the value of t-statistics.

Table 5: Results of estimates of ECM

	ROW (2,0,2,1)	JP (1,2,2,2)	SG (1,2,2,2)	US (2,0,0,0)	CN (1,0,2,1)	MY (2,2,2,2)	KR (2,1,2,2)	TL (2,2,2,2)
Constant					-6.285*** [-9.479]			-27.93*** [-6.537]
Δ*LnTB (-1)*	0.259** [2.381]			0.097** [2.427]		0.277* [2.157]	0.411*** [3.643]	0.229** [2.544]
Δ*LnYD*	-2.294*** [-8.827]	-1.533*** [-3.503]	-1.276* [-1.824]	2.716* [2.026]	3.650*** [3.391]	-1.710 [-1.416]	-0.107 [-0.137]	1.548 [1.532]
Δ*LnYD (-1)*		-3.194*** [-5.779]	3.624*** [4.716]			-7.512*** [-3.435]		-4.570* [-2.224]
Δ*LnYF*	3.537*** [7.294]	1.649** [2.940]	0.217 [0.354]	-1.516 [-0.642]	-4.551*** [-4.079]	3.349** [2.946]	-4.078*** [-4.732]	-2.630*** [-3.722]
Δ*LnYF (-1)*	-1.055* [-1.866]	3.679*** [5.562]	-1.914** [-2.841]		-1.458*** [-3.446]	5.432** [2.745]	-1.638** [-2.847]	3.355** [2.547]
Δ*LnRE*	0.145* [2.122]	-1.807*** [-3.534]	2.434** [2.901]	7.012*** [4.171]	2.843** [2.921]	-5.289*** [-3.364]	7.315*** [6.344]	3.109** [3.122]
Δ*LnRE (-1)*		-3.091*** [-4.720]	3.104*** [3.792]			-6.999** [-2.822]	2.185*** [3.437]	-4.229* [-2.258]
Δ*B1*	-0.076** [-2.580]	-0.150*** [-3.799]	-0.186*** [-3.363]	2.314*** [26.064]		-0.447*** [-3.755]	-0.109 [-1.818]	
Δ*B2*	-1.105*** [-4.245]	0.082** [2.296]	0.162** [2.475]	0.402*** [3.948]			0.677** [7.220]	
ECT (-1)	-1.674*** [-6.416]	-0.536*** [-8.352]	-0.897*** [-5.476]	-1.314*** [-13.932]	-0.937*** [-9.528]	-1.239*** [-5.600]	-1.436*** [-8.274]	-1.096*** [-6.518]

Notes: ***, **, and * represent statistical significance at the 1%, 5%, and 10% level, respectively. The dependent variable is the first difference of export Δ LnEX for export model and the first difference of import Δ LnIM for import model; the number inside the parenthesis is the value of t-statistics subscript (-1) after a variable represents the lag.

Table 4 presents the results of the long-run coefficient estimates using the ARDL approach. Based on the results, the trade balance is positively and significantly affected by real depreciation for both aggregate model and disaggregate models except Singapore. Real income in home country has a positively significant impact on the trade balance for disaggregate models except Singapore and the United States and negatively significant impact for aggregate model. In contrast, real income in trading partner countries has a negatively significant impact on the trade balance for disaggregate models except Singapore and the United States and positively significant impact for aggregate model.

We obtain the short-run parameters by estimating an error correction model associated with the long-run estimates. The results of the error correction model are reported in Table 5. Real exchange rate in the short run still has a positive and significant impact on the trade balance for both aggregate model and disaggregate models except Japan and Malaysia. However, it turns into a negative and significant impact on the trade balance at first lag for Thailand. For all models, the coefficient of the error correction term is significant and negative. The magnitude of this coefficient implies that nearly ($-\lambda_i$*100) percent of any disequilibrium is corrected in the next ($-12/\lambda_i$) months.

6. Conclusions

This paper analyzes aggregate model and disaggregate models to test the effects of real exchange rate on Vietnam trade balance in both short run and long run during the period 1990– 2013. Annual time-series data covering the study period were used in the application of the econometric method known as the ARDL bounds testing approach to cointegration with an error correction model. Recent analytical data techniques were also used to diagnose and check the properties of the time-series data. The models were then used to estimate the long-run and short-run elasticities and their significance.

The long-run results indicate that real depreciation in exchange rate significantly plays a positive role on improving the trade balance in both aggregate model and disaggregate models, but insignificantly in Singapore model. Income in home Vietnam and its trading partners have, respectively, negative and positive significant impacts on the trade balance for disaggregate models. However, the signs turn to positive and negative for aggregate model. They mean Marshall-Lerner condition holds in both aggregate model and disaggregate models except Singapore model in the long-run.

In order to assess the J-curve phenomenon, we estimate the short-run coefficients of the real exchange rate. The results show that there are convincing evidences of J-curve only in Japan, Malaysia and Thailand models.

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References

Banerjee, A., R. L. Lumsdaine and J. H. Stock, (1992), Recursive and Sequential Tests of the Unit Root and Trend-Break Hypothesis: Theory and International Evidence. Journal of Business and Economic Statistics, 10, pp. 271-287.

Emmanuel, Z. and Ronald, T. C., (2014), The J-curve Dynamics of South African Trade: Eviedence from the ARDL Approach, European Scientific Journal, 10(19), pp. 346-358.

Engle, R. F. and C. W. J. Granger, (1987), Cointegration and Error Correlation: Representation, Estimation and Testing. Econometrica, 55, pp. 251-71.

Christiano, L. J., (1992), Searching for a Break in GNP. Journal of Business and Economic Statistics, 10, pp. 303-319.

Johansen, S., (1988), Statistical Analysis of Cointegration Vectors. Journal of Economic Dynamics & Control, 12, pp. 2131-54.

Perron, P., (1989), The Great Crash, The Oil Price Shock, and The Unit Root Hypothesis, Econometrica, 57(6), pp. 1361-1401.

Perron, P., (1997), Futher Evidence on Breaking Trend Functions in Macroeconomic Variables, Journal of Econometrics, 80(2), pp. 355-385.

Perron, P. and T. J. Vogelsang, (1992), Nonsationarity and Levels Shifts with an Application to Purchasing Power Parity. Journal of Business and Economic Statistics, 10, pp. 301-320.

Pesaran, M. H. and B. Pesaran, (1997), Microfit 4.0. Oxford: Oxford University Press.

Pesaran, M. H. and Y. Shin, (1999), An Autoregressive Distributed Lag Modeling Approach to Cointegration Analysis. Chapter 11 in Econometrics and Economic Theory in the 20th Century: The Ragnar Frisch Centennial Symposium, Strom, S. (ed.). Cambridge University Press: Cambridge.

Pesaran, M. H., Y. Shin and R. Smith, (2001), Bounds Testing Approaches to the Analysis of Level Relationships. Journal of Applied Econometrics, 16, pp. 289-326.

Phillips, P. and B. Hansen, (1990), Statistical Inference in Instrumental Variables Regression with I(1) Process. Review of Economic Studies, 57, pp. 99-125.

Rose, A. K., (1990), Exchange Rates and the Trade Balance: Some Evidence from Developing Countries, Economics Letters, 34, pp. 271-275.

Rose, A. K. and Yellen, J. L., (1989), Is There a J-curve? Journal of Monetary Economics, 24, pp. 53-58.

Tihomir, S., (2004), The Impact of Exchange Rate Change on the Trade Balance in Croatia, IMF Working Paper, WP/04/65.