Impacts of Exchange Rate on Vietnam-Japan Trade Balance: A Nonlinear Asymmetric Cointegration Approach

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Abstract

The paper examines the impacts of exchange rate on Vietnam's trade balance with Japan based on the employment of industry-level data in a set of linear and nonlinear auto-regressive distributed lag models. Results from the models indicate a degree of bias in regression when using aggregate data and a linear ARDL approach. Among 19 industries under consideration, the NARDL model presents different responses from 16 industries, which account for 40% of imports and 60% of exports between Vietnam and Japan, to exchange rate movements. The trade balance of each industry responds differently towards exchange rate and asymmetric reactions are found in 9 out of 16 industries affected by changes in exchange rate. The model using aggregate data shows that exchange rate positively affects Vietnam-Japan trade balance in case of currency depreciation, whereas currency appreciation has no impact on the trade balance between the two countries. Besides, results of the model using aggregate data reveal that the level of economic activity of Japan exerts positive impacts on Vietnam's trade balance with Japan.

1. Introduction

Japan is one of Vietnam's most important trade partners. The market accounts for about 10% of total export-import turnover and ranks fourth among the top trading partners of Vietnam (Data from the General Department of Vietnam Customs). It is noticeable that Vietnam has maintained a relatively balanced trade relationship with Japan in recent years. Japan is considered a potential market that Vietnam has not been able to fully exploit its advantages – given all the economic and diplomatic ties established by both countries, especially after the signing of the Vietnam-Japan economic partnership agreement on 25th December 2008, which later came into force on 1st October 2009. In fact, this is regarded Vietnam's first bilateral free trade agreement (FTA), with both countries giving much more preferential treatments for mutual trade and economic partnership as compared with the ASEAN-Japan FTA.

Figure 1: Vietnam-Japan bilateral trade turnover 1995-2017 (million USD)

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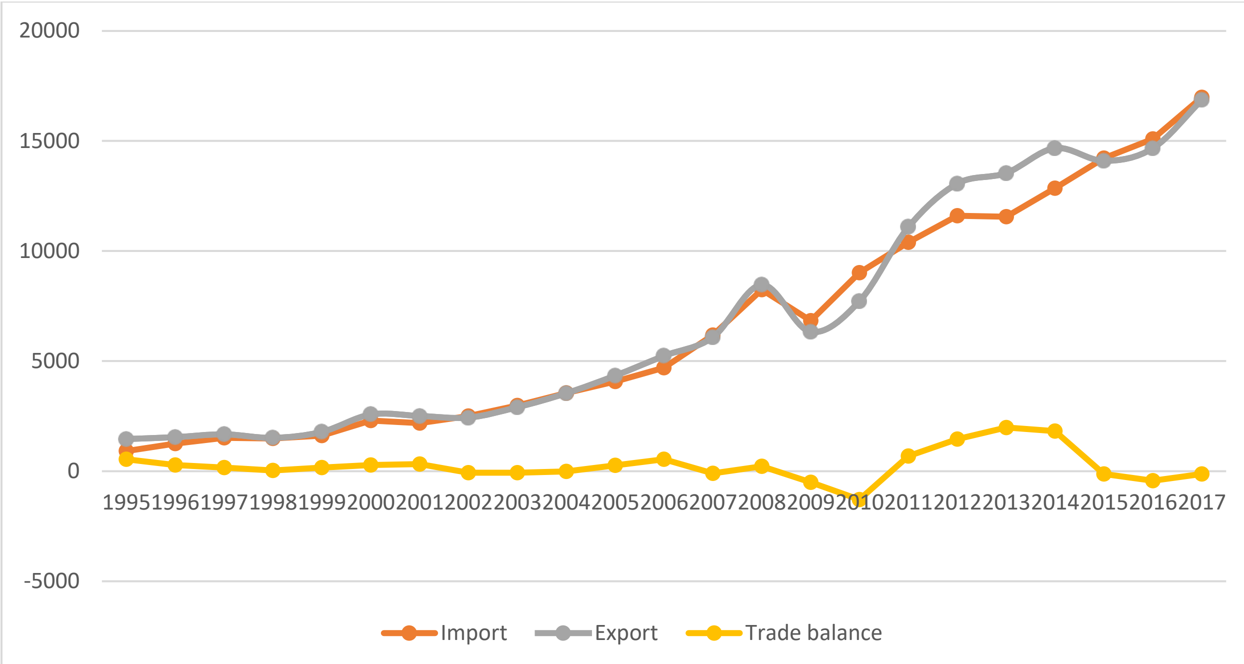
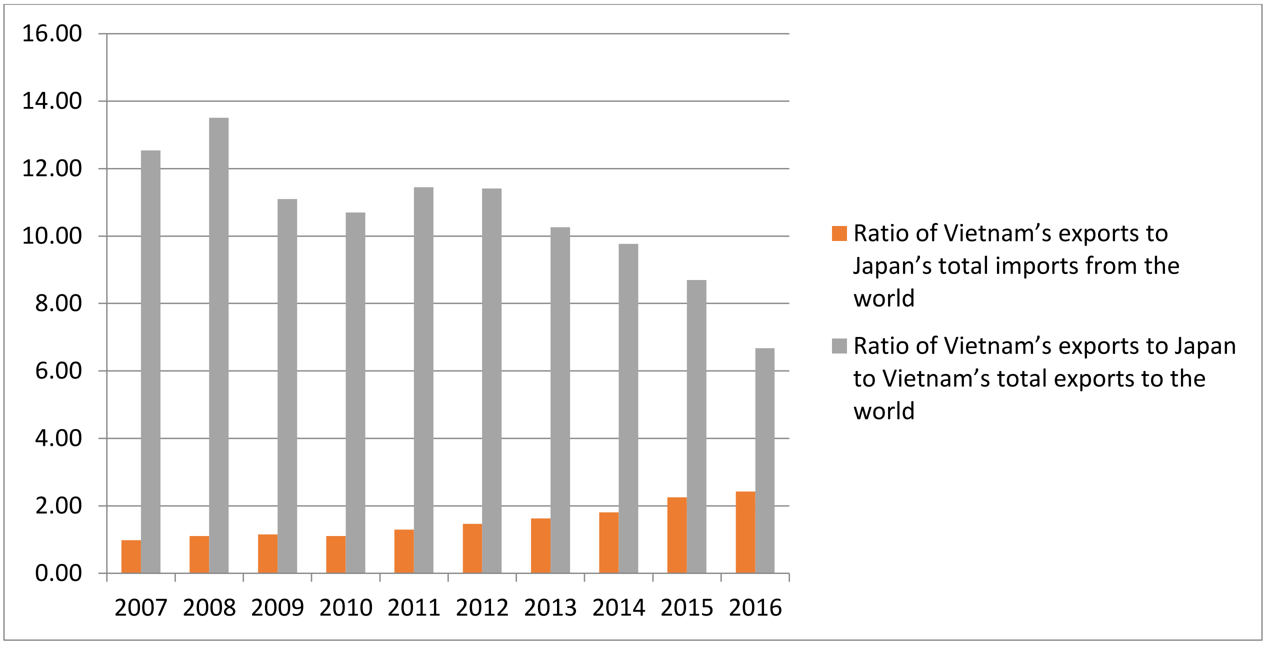


Source: General Statistics Office and author's calculation

Figure 1 shows that total trade turnover between Vietnam and Japan continuously increased in the past 20 years, especially after the economic partnership agreement between two countries was signed in 2008 with various preferential treatments granted to each other. Both the lines have positive slopes, highlighting the fact that, from 2009 to 2017, Vietnam's exports to Japan increased by 160% while imports also experienced a lower growth rate of 140%. Regarding the trade balance, between 1995 and 2017, Vietnam achieved trade surplus for most of the period, except for 2009-2010 and the most recent three years 2015-2017.

Therefore, it is evident that after the signing of this economic partnership agreement, bilateral trade value has while exports and imports were spotted to rise at different rates - though the difference in speed was rather small. During the last three years, imports have outpaced exports, causing a trade deficit in Vietnam's bilateral trade relations with Japan. In particular, imports from Vietnam just accounted for 2.42 % of market share in the Japanese market in 2016 (*Figure 2*) while only 6.7% of Vietnam's exports were delivered to Japan. The chart also illustrates that though the proportion of Vietnam's goods exported to Japan has increased in recent years, the role of the Japanese market as a Vietnam's major trading partner steadily declined. Indeed, from a moderate market share of 11.45% in 2011, Vietnam's goods exported to Japan dropped to a low of 6.7% in 2016. In general, these figures demonstrate that Vietnam has failed to take full advantage of the potential benefits brought by the FTA.

Figure 2: Share of Vietnamese goods in Japanese market (2007-2016)



Source: ITC (International Trade Centre) and author's calculation

A lot of experts, though with different perspectives, have suggested that Vietnam's growing trade deficit in recent years (2015-2017) stemmed from the appreciation of the Vietnamese Dong (VND) against the Yen (JPY). However, few quantitative studies have been conducted to support this argument so far. For that reason, this paper aims to answer the question of how exchange rate affects Vietnam-Japan trade balance and whether or not exchange rate is an effective tool to improve Vietnam's trade balance with Japan.

The rest of the paper is organized as follows. Section 2 provides an overview of previous research and addresses potential research gaps. Section 3 focuses on model specification and empirical methodology, as well as steps to conduct estimation procedures for the ARDL and NARDL models. Section 4 presents and discusses the empirical results of the models. Section 5 sketches out major conclusions and policy recommendations of the paper.

2. Literature review

The relationship between exchange rate and trade balance has always been a highly-debated topic among academics over the past decades. However, since the middle of the twentieth century, with developments in macroeconomic and econometric analysis, several empirical studies have been carried out. Despite the emergence of more advanced research methods and the availability of more comprehensive databases, the relationship between exchange rate and trade balance still causes much controversy and no consensus has been reached on this matter so far. In general, most studies could be divided into three groups that represent three different approaches commonly adopted by scholars: i) Elasticity approach, ii), Keynesian absorption approach, and iii) Monetary approach. Both Keynesian absorption and monetary approach were developed with a special focus on macroeconomic linkages and identities while elasticity approach is mainly adopted to study microeconomic relationships. Thus, the relationship between exchange rate, trade balance and other macro variables will be better clarified through the first two approaches. Still, the literature review shows that very few empirical studies have employed these two methods in their research.

Most studies on the relationship between exchange rate and trade rely on the test of the Marshall-Lerner condition (MLC) through identifying the price elasticities via export and import demand functions, and more importantly, to examine the existence of the J-curve following currency devaluation. Typical studies that implemented the elasticity approach based on aggregate export and import demand functions are: Bahmani-Oskooee (1991); A. Arize (1987); A. C. Arize (1994); Khan (1974); Houthakker and Magee (1969); Magee (1973); Junz and Rhomberg (1973); Laffer (1977); and Bahmani-Oskooee (1985).

Moreover, as confirmed by Bahmani-Oskooee and Zhang (2014), the Marshall-Lerner condition can only explore the indirect impacts of exchange rate on trade balance via the export demand and supply functions. As such, many other studies have attempted to investigate the direct relationship between exchange rate, trade balance and other macro variables (Anju & Uma, 1999; Bahmani-Oskooee, 1985; Bahmani-Oskooee & Pourheydarian, 1991; Felrningham, 1988; A. Rose & J. L. Yellen, 1989). Most of them used the cointegration analysis to evaluate the relationship between variables in the long run and error-correction modeling to observe the short-term impacts of exchange rate on trade balance and the existence of the J-curve effect. Yet, these papers gave conflicting conclusions on the role of exchange rate in export-import performance. Bahmani-Oskooee and Ardalani (2006) then pointed out that the use of aggregate export-import data might have led to biased results.

In a recent study, Baek (2013) also indicated that studies looking at the relationship between exchange rate and trade normally have three different approaches for data usage: *First*, the approach based on aggregate trade data, or data on the exports and imports of the whole economy; *Second*, the approach based on aggregate trade data at the bilateral level; *Third*, the approach based on the examination of trade data at industry level.

Specifically, the first approach focuses on the use of aggregate export and import data between a country and the rest of the world while assessing the impacts of exchange rate depreciation or appreciation (e.g. Wilson and Takacs (1979) Bahmani-Oskooee (1986) Felmingham and Divisekera (1986)...). These studies drew different conclusions on the impacts of currency devaluation on trade balance. Meanwhile, the second approach uses bilateral trade data between a country and its major trading partners to study the effects of exchange rate on trade (e.g. A. K. Rose and J. L. Yellen (1989) Bahmani-Oskooee and Goswami (2004) Bahmani-Oskooee and Kantipong (2001) Halicioglu (2007)…). However, similar to the first approach, the authors also provided mixed (different or even opposite) conclusions on the impacts of exchange rate on trade. In fact, recent debates have suggested that such discrepancies or contradictions came from different choices of data approach, as the use of aggregate trade data has led to biased results. Since the work of Bahmani-Oskooee and Ardalani (2006), there has been a growing body of literature arguing that the first and second approaches may suffer from the aggregation bias problem as exchange rate may put significant impacts on some particular industries or commodities yet might not bring about any/or just less robust effects, sometimes even in a negative way, to some other commodities or industries. Hence, using aggregate trade data may lead to mixed results, depending on which commodity groups are given the dominant positions.

Bahmani-Oskooee and Ardalani (2006) was the first research work to address the shortcomings of the first and second approaches mentioned above. The paper examined the relationship between the trade flows of the US and the rest of the world, and between the US and its major trading partners in different commodity groups/industries. The authors found that a depreciation of the US dollar would stimulate the exports of many commodity groups/industries for the US, while there would be no significant impacts on the imports of most industries. More recently, Baek (2013) estimated the impacts of exchange rate on bilateral trade between South Korea and Japan. Results show that Korea's exports to and imports from Japan were relatively sensitive to exchange rate in the short run, but less responsive in the long run. Another similar work of Baek (2014) on bilateral trade between South Korea and the US illustrated that Korea's major export industries were significantly affected by exchange rate volatility, both in the long run and the short run. Meanwhile, Korea's imports were found insensitive to changes in exchange rate.

In addition, some papers have employed the industry-level data approach to inspect exchange rate's direct impacts on trade balance. For example, (Ardalani & Bahmani-Oskooee, 2007) investigated the direct relationship between exchange rate and trade balance (or the ratio of exports to imports) of 64 SITC industries (Standard International Trade Classification) in the US market. Results revealed that the J-curve effect only exists in 6 industries and exchange rate affects trade balance in 22 industries in the long run.

Besides, most recent studies mentioned the presence of biased estimates in previous papers as they did not examine the asymmetric reactions of trade balance to exchange rate changes. These studies highlighted the limitations of those previous papers when studying the impacts of exchange rate on trade balance based on a weak and inadequate assumption, saying that trade balance's responses to changes in exchange rate are always symmetrical whether the domestic currency appreciates or depreciates. Thus, numerous evidence has been found to prove that this could be a misleading assumption which causes ambiguity in conclusions on the impacts of exchange rate on trade balance (A. C. Arize, Malindretos, & Igwe, 2017; Bahmani-Oskooee & Fariditavana, 2015, 2016)

The employment of quantitative models to study the role and impacts of exchange rate on trade in Vietnam is increasingly drawing attention from Vietnamese academics. T. T. T. Pham (2012) found both short-term and long-term effects of exchange rate on trade balance in Vietnam. Shortly after the VND depreciates, trade balance will get worsen. However, it will improve after four quarters and a new equilibrium will be established after twelve quarters. The author used the autoregressive distributed lag (ARDL) model to study the long-term effects and spotted the improvement of trade balance when the real exchange rate depreciates. An error correction model (ECM) was also implemented. Its results underscored an immediate decline in trade balance in the short run after the domestic currency depreciates.

T. H. H. Pham and Nguyen (2013) used Vietnam's data series for the 1990-2007 period to evaluate possible linkages between FDI inflows to Vietnam, Vietnam's exports and exchange rate. The authors applied the cointegration method for the panel data used in Pedroni (1999). The paper concluded that FDI inflows into Vietnam and Vietnam's exports are significantly influenced by exchange rate. In addition, exports from Vietnam to its major trading partners are also considerably affected by FDI. Thus, it can be affirmed that exchange rate affects exports via two channels: directly through relative commodity prices and indirectly via FDI.

Hoang (2013) ran a simplified VAR model to estimate the responses of trade balance to VND/USD real exchange rate shocks. The study indicated that there does exist a J-curve for Vietnam and its effects last for eleven months.

Vu (2013) assessed the impacts of exchange rate on Vietnam's exports to its trading partners such as the US, Korea, EU, Japan… using the VECM model. The study examined the effects of exchange rate on each commodity group for each trading partner, while simultaneously investigating the impacts of the Chinese factor (in cluding Yuan exchange rate and the scale of china's import to Vietnam's trading partner) on Vietnam's exports to major trading partners. Results implied that "VND depreciation exerts positive impacts on exports. However, it is noteworthy that these impacts not only depend on the characteristics of each commodity group but also on the nature of the markets (although both factors are not mutually exclusive). For example, Korean and Japanese markets do not explicitly respond to exchange rate movements".

Mai (2016) observed and estimated the impacts of exchange rate and other factors on Vietnam's fishery exports to the US and Japanese markets. The paper used secondary data from Q1/2004 to Q4/2014 for the Ordinary Least Squares (OLS) approach. Results exposed that the real exchange rates (VND/JPY, VND/USD); Vietnam's fishery production output; the volume of fishery exports to countries other than the importing ones; income of importing countries (GDP) and seasonal factors do influence Vietnam's total fishery export turnover in both the US and Japanese markets. In particular, VND/USD real exchange rate positively affects Vietnam's fishery export turnover to the US market while VND/JPY real exchange rate appears to put a negative impact on Vietnam's fishery export turnover to Japanese market.

Thus, the literature review acknowledges a large number of studies which attempt to examine the impacts of exchange rate on trade (namely exports, imports, trade balance). Most of them focused on the impacts of exchange rate on aggregate volume/turnover of exports/imports of the whole economy based on the elasticity approach – which is normally accompanied by the adoption of the BRM model, the Marshall-Lerner condition and the J-curve effect. With respect to studies about Vietnam, apart from the works of Vu (2013) and Mai (2016), there has been no research estimating exchange rate impacts on Vietnam's trade with a focus on each commodity group/industry to address the shortcomings of the use of aggregate trade data as mentioned above. However, the work of Vu (2013) only considered the impacts of exchange rate on exports without investigating the role of exchange rate in determining trade balance between Vietnam and its trading partners. The research paper conducted by Mai (2016), meanwhile, was limited to the case of the fishery sector's exports to the US and Japanese markets.

Another limitation of current studies on the role of exchange rate in Vietnam's trade balance is that these papers only based on the conventional assumption that the responses of trade balance to exchange rate are always symmetrical and ignored other possibilities. To date, there has been no research that uses an asymmetric non-linear model to examine asymmetric impacts of exchange rate on Vietnam's trade balance. Therefore, the goal of this paper is to tackle the weaknesses and shortcomings mentioned above and to provide a more comprehensive methodology for examining the impacts of exchange rate on Vietnam-Japan bilateral trade which can effectively limit the presence of bias in regression, thereby drawing policy recommendations for Vietnam to improve the effectiveness of the monetary policy, especially with regard to its impacts on trade in the current period.

This is significantly meaningful for policy-makers as it provides the overall picture of the role of exchange rate in trade and suggests a string of policy recommendations for the adjustment of exchange rate that is in accordance with the development goals of each industry and helps to effectively control macro variables, stabilize the economy, stimulate exports and improve trade balance.

3. Model specification and empirical methodology

The literature review suggests that the models used to examine the relationship between exchange rate and trade balance normally follow two main approaches: (i) firstly, the model looks at the indirect effects of exchange rate on trade balance through the export and import demand functions; and (ii), secondly, the model considers the direct effects of exchange rate on trade balance with dependent variables that might denote the difference of exports minus imports or the ratio of exports to imports. Within the scope of the research, the author examined the effects of exchange rate on trade balance by a model which directly assesses the impacts of exchange rate on the ratio of exports to imports.

Derived from the study of A. Rose and J. L. Yellen (1989) as well as the model applied in Bahmani-Oskooee and Baek (2016), the author proposed a research model to consider the impacts of exchange rate on the trade balance between Vietnam and Japan with industry-level data.

It is notable that, in the study of A. Rose and J. L. Yellen (1989), the authors developed a trade model for the two countries. The study started with an import demand function, whereby home country's import demand for goods (foreign country) depends on its actual income (foreign country) and the relative prices of imported goods. In particular, real income is expected to have a positive impact while relative prices are predicted to exert a negative impact on import demand. The import demand function of two trading partners will be presented as follows:

$$D_m = D_m(Y, P_m) \text{ và } D_m^* = D_m^*(Y^*, P_m^*) \quad (1)$$

Of which $D_m(D_m^*)$ is the import demand of the home country (foreign country), Y (Y^*) is the real income of home country (foreign country), P_m (P_m^*) is the relative price of imported goods as compared with domestically produced goods of the home country (foreign country), which is measured in the currency of the home country (foreign country). Similarly, the export demand function in a perfectly competitive market is presented as follows:

$$S_x = S_x(p_x) \text{ và } S_x^* = S_x^*(p_x^*) \quad (2)$$

Of which $S_x(S_x^*)$ is the export supply of the home country (foreign country), p_x is the relative price of exported goods of the home country (calculated by deviding the domestic currency price of exported good, P_x , by the domestic price level, P), p_x^* is the relative price of exported goods of the foreign country (calculated by dividing the domestic currency of exported goods, P_x^*, by the foreign price level, P^*).

The relative import price is calculated as follows:

$$p_m = \frac{E \times P_x^*}{P} = \frac{E \times P^*}{P} \times \frac{P_x^*}{P^*} = RER \times p_x^* \quad (3)$$

Of which E is the nominal exchange rate, and RER is the real exchange rate which is defined as:

$$RER = E \times \frac{P^*}{P}$$

Similarly, the relative import price of the foreign country is:

$$p_m^* = \frac{p_x}{RER} \qquad (4)$$

At the equilibrium of the market, the volume of exported goods and the relative price between two countries are determined by the two following equilibrium conditions:

$$D_m = S_x^* \text{ và } D_m^* = S_x \ (5)$$

Thus, the real trade balance of the home country is the net export turnover measured in domestic currency divided by the domestic price level (P):

$$B = p_x \times D_m^* - RER \times p_x^* \times D_m \ (6)$$

From the equations (2.11) and (2.16), we have a simplified equation as follows:

$$B = B(REX, Y, Y^*)$$

Accordingly, Rose and Yelle (1989) developed this following model in their research:

$$TB_{jt} = a + blnY_{us,t} + clnY_{jt} + dlnREX_{jt} + \epsilon_t \ (7)$$

Of which TB_{jt} is the trade balance of the US and its trading partner J, $Y_{us,t}$ is the real income of the US, Y_{jt} is the real income of the partner country, and REX_{jt} is the real exchange rate between the USD and the currency of the partner country.

On the basis of the work of A. Rose and J. L. Yellen (1989), Bahmani-Oskooee and Baek (2016) developed a model to examine the relationship between exchange rate and trade balance between South Korea and the US with an industry-based approach which uses data of each specific industry. The model is presented as follows:

$$\ln\left(\frac{M_i}{X_i}\right) = a + blnY_t^{US} + clnY_t^{KR} + dlnREX_t + \epsilon_t \ (8)$$

Of which M_i denotes the volume of imports from South Korea to the US for the commodity/industry i, X_i is the volume of exports from the US to the Korean market for the commodity/industry i. $Y_t^{US}(Y_t^{KR})$ is real income of the US (South Korea), REX_t is the bilateral real exchange rate. As the ratio ${M_i}/{X_i}$ is unit free, the model can be easily transformed into a log-linear model.

Based on the work conducted by Bahmani-Oskooee and Baek (2016), the author built a model to research the relationship between exchange rate and trade balance of Vietnam with Japan by commodity group/industry. The model is illustrated as follows:

$$\ln\left(\frac{X_i}{M_i}\right) = a + blnY_t^{VN} + clnY_t^{JP} + dlnREX_t + \epsilon_t \text{ (9)}$$

Of which M_i represents the volume of imports to Vietnam from Japan for the commodity group/industry i, X_i represents the volume of exports from Vietnam to Japan for the commodity group/industry i. $Y_t^{VN}(Y_t^{JP})$ is the real income of Vietnam (Japan), REX_t is the bilateral real exchange rate. Accordingly, b is expected to be negative while c is predicted to be positive. REX is seen to be rising when the VND depreciates, thus d should be positive.

The equation (9) is applied to estimate only the long-run coefficients. To estimate short-run impacts of the variables on trade balance, especially the short-run impacts of exchange rate (to consider the J-curve effect), following the approach of the paper, the equation (9) will be rewritten in the form of an error correction model as follows:

$$\Delta ln(\frac{X_i}{M_i})_{t-k} = \alpha + \sum_{k=1}^{n} \beta_{t-k}\Delta\ln(\frac{X_i}{M_i})_{t-k} + \sum_{k=0}^{n} \delta_{t-k}\, \Delta lnY_{t-k}^{VN} + \sum_{k=1}^{n} \gamma_{t-k}\Delta lnY_{t-k}^{JP} + \sum_{k=0}^{n} \delta_{t-k}\, \Delta lnREX_{t-k} + \varphi_1\ln(\frac{X_i}{M_i})_{t-1} + \varphi_2\mathrm{lnY}_{t-1}^{VN} + \varphi_3\mathrm{lnY}_{t-1}^{JP} + \varphi_4\mathrm{lnREX}_{t-1} + \mu_{t-1} \text{ (10)}$$

Pesaran, Shin, and Smith (2001) recommended a standard F-test for the hypotheses: H_0: $\varphi_1=\varphi_2=\varphi_3=\varphi_4=0$ and H_1: $\varphi_1\neq0, \varphi_2\neq0, \varphi_3\neq0, \varphi_4\neq0$. If the F-statistic is statistically significant, the null hypothesis H_0 will be rejected or in other words, there does exist cointegration among variables.

Estimation using the non-linear ARDL model

A vital assumption in both equation (9) and (10) is that all independentvariables will exert symmetrical impacts on the trade balance. With respect to the exchange rate, this assumption implies that the reactions of trade balance to exchange rate change in case of currency depreciation are the same for currency appreciation. Alternatively, there are some arguments claiming that commercial producers and traders may respond differently to currency depreciation and appreciation, or, exchange rate may have asymmetrical impacts on trade balance. In order to test this hypothesis, studies of Bahmani-Oskooee and Fariditavana (2015); Delatte and López-Villavicencio (2012); A. C. Arize et al. (2017) have included new variables to describe the movements of the variable LNREX which originally denotes logarit of real bilateral exchange rate. Of which, the variable NEG specifies the decrease of the exchange rate. In this paper, it denotes the appreciation of the VND, and the variable POS signifies the increase of the exchange rate or the depreciation of the VND. Specifically, POS and NEG are defined as follows:

$$POS_t = \sum_{j=1}^{t} \Delta lnREX_j^+ = \sum_{j=1}^{t} \max(\Delta lnREX_j, 0)$$

$$NEG_t = \sum_{j=1}^{t} \Delta lnREX_j^- = \sum_{j=1}^{t} \min(\Delta lnREX_j, 0)$$

Shin, Yu, and Greenwood-Nimmo (2014) suggested to replace the variable lnREX in the error correction model (9) by the two new variables POS and NEG. Thus, the equation (9) will be rewritten and named NARDL or the non-linear autoregressive distributed lag model.

$$\Delta ln(\frac{X_i}{M_i})_{t-k} = \alpha + \sum_{k=1}^{n} \beta_{t-k} \Delta \ln(\frac{X_i}{M_i})_{t-k} + \sum_{k=0}^{n} \delta_{t-k} \Delta lnY_{t-k}^{VN} + \sum_{k=1}^{n} \gamma_{t-k} \Delta lnY_{t-k}^{DT} + \sum_{k=0}^{n} \pi_{t-k} \Delta POS_{t-k} + \sum_{k=0}^{n} \vartheta_{t-k} \Delta NEG_{t-k} + \varphi_1 \ln(\frac{X_i}{M_i})_{t-1} + \varphi_2 \mathrm{lnY}_{t-1}^{VN} + \varphi_3 \mathrm{lnY}_{t-1}^{DT} + \varphi_4 \mathrm{POS}_{t-1} + \varphi_5 \mathrm{NEG}_{t-1} + \mu_{t-1} \quad (11)$$

The authors proved that the bounds F-test employed in the ARDL model might be used in the NARDL model in a similar way. If the estimation coefficients φ_4 and φ_5 have the same signs and equal in magnitude, it means exchange rate have symmetrical impacts on trade balance in the long run. In contrast, if the two coefficients have opposite signs and different values, a firm conclusion about the existence of an asymmetrical correlation between exchange rate and trade balance can be drawn. In order to test the presence of asymmetrical impacts, the authors relied on the Wald test with the null hypothesis H_0: φ_3=φ_4. Similarly, short-run asymmetrical impacts will be tested based on the hypothesis H_0:$\sum_{k=0}^{n} \pi_{t-k} = \sum_{k=0}^{n} \vartheta_{t-k}$

4. Estimation results of the models

4.1. Diagnostic tests

The adoption of unit root tests is to guarantee that all independent variables will be stationary at I(0) or I(1) or mixed, but not the I(2) and dependent variables must stationary in I (1) – which is an indispensable condition for the estimation of the ARDL model. The testing for stationarity will be performed through a string of unit root tests for variables included in the equation (1).

The study used the standard Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. The results showed that most of the independent variables are stationary of order zero or order one according to the ADF standard with a 1% significant level and PP standard with a 5% significant level. The dependent varables are found to be not stationary of order zero, satisfying the necessary conditions of the ARDL model. Due to the large number of models in this paper, the results of unit root tests are not presented in detail.

The selection of the optimal lag length for the model (10) and (11) will base on the value of the AIC standards obtained from the unlimited estimation of the ARDL models. On the basis of the comparison of these standards, the optimal lag length for the research models will be determined determined accordingly, first starting with a maximum of 6 lags. The results of the models with optimal lag length will be presented below and in the appendix.

Results of the bounds test for each model will be illustrated in detail in the table 4 and table 5 (see appendix). In general, the results are as follows:

For the ARDL models: F-statistic revealed that there are 12/19 commodity groups/industries that witness a long-term relationship between variables included in the model. 6 groups/industries do not detect the presence of cointegration.

For the NARDL models: F-statistic showed that there are 16/19 commodity groups/industries that can spot a long-term relationship between variables embedded in the model. 6 groups do not find the presence of cointegration.

On the other hand, Bahmani-Oskooee and Ardalani (2006) suggested that the results of the F-bounds test are very sensitive to the number of lags chosen for the variables. It is also important to remind that Banerjee, Dolado, and Mestre (1998) and Banerjee et al. (1998) used the standards of the error-correction term (EC_{t-1}) to consider the existence of a long-term relationship between variables in the model. Accordingly, if the error correction term is negative and statistically significant, it is possible to conclude that there really exists a relationship between variables in the long term. Results of the error correction model are presented in the Table 4 and 5 (see appendix), showing that all the error correction terms are negative and statistically significant in every model. Thus, it is possible to conclude that there does exist a long-term relationship between variables in every estimation model below, which satisfies the conditions for a further analysis of these models.

Furthermore, the paper also performed a set of model diagnostic tests including: a test for autocorrelation (LM test), a test for heteroscedasticity (HK test), a general specification test for the linear regression model (RESET test), a test for parameter stability (CUSUM and CUSUMSQ test), and the Wald test to check whether an asymmetric response exists in the short term and long term. Results of these tests are presented in the Table 4 (for the ARDL models) and Table 5 (for the NARDL models). The results also confirmed that there is no existence of autocorrelation, heteroscedasticity in the models and the models are correctly specified. The CUSUM and CUSUMSQ tests showed constancy of the coefficients in most models (stable coefficients in both tests are denoted by "S" while unstable one called by "US"). Regarding the Wald test, its results confirms the presence of long-run asymmetrical impacts in 13 commodity groups and short-run effects in 12 commodity groups

4.2. Estimation results of long-run coefficients in the ARDL models

The estimation results of long-run coefficients in the ARDL models are presented in the Table 1. The signs of the long-run coefficients vary among different commodity groups.

Table 1: Estimation results of long-run coefficients in the ARDL models

Product code	LRER		INDVN		INDCN	
Japan						
SC01	0.9259	(0.5741)	-0.2144	(0.4311)	-0.0679	(1.3341)
SC02	-2.6837***	(0.7685)	-1.1848**	(0.5717)	-1.0245	(2.1711)
SC04	2.1356	(1.5715)	-0.8336	(0.7232)	4.8088	(4.1626)
SC05	1.2410	(1.7768)	0.1450	(1.3120)	-6.0323	(4.0952)
SC06	-0.4224	(0.5138)	-0.3245	(0.4101)	2.2234	(1.8443)
SC07	-0.7493	(0.6074)	0.0873	(0.4362)	3.0354	(2.5639)
SC08	-2.0890***	(0.7228)	0.3659	(0.5423)	-2.8137*	(1.5610)
SC09	-1.0060	(0.6751)	-0.6522	(0.5382)	5.7116**	(2.7731)
SC10	0.6096	(0.3734)	0.0238	(0.2879)	-1.4573	(0.9963)
SC11	-0.5768***	(0.1792)	0.3379**	(0.1359)	-0.8453	(0.5476)
SC12	-0.8668	(0.5671)	-0.3175	(0.4711)	-1.3831	(1.4868)
SC13	-1.4528***	(0.1352)	-0.7282***	(0.1019)	1.8254***	(0.3847)
SC14	-0.0108	(0.3482)	0.6016**	(0.2545)	-0.6572	(0.8445)
SC15	-0.6854***	(0.2263)	0.7305***	(0.1742)	0.6857	(0.6466)
SC16	0.1041	(0.1933)	0.1602	(0.1673)	-0.3780	(0.5120)
SC17	-0.1579	(0.6940)	-0.0678	(0.5293)	4.3949**	(2.1895)
SC18	-0.2416	(0.3245)	-0.6376**	(0.3020)	-1.3835	(0.8729)
SC20	-0.1908	(0.1849)	-0.1838	(0.1413)	-1.1370**	(0.4960)
SC21	2.0190***	(0.3432)	0.7612***	(0.2582)	1.1869	(1.1068)
SCtotal	0.0808	(0.3714)	0.0909	(0.2678)	2.2841	(1.5085)

*Note: 1. *, **, *** means the regression coefficient is statistically significant at the 1%, 5% and 10% level respectively*

2. The value in brackets is the standard error of the estimate of the coefficient

The estimation results of the long-run coefficients included in the models showed that there are only 6 commodity groups/industries (accounting for 27% of imports and 33% of exports of Vietnam for this market) which are affected by exchange rate, including: vegetable products (S02), leather and leather products (S08), textile materials and textile products (S11), stone and glass products (S13), base metals and metal products (S15), works of art, collectors' pieces and antiques (S21). Most commodity groups/ industries receive negative signs, except for the group of artworks (S21). The income coefficient of Vietnam suggested there are 6 commodity groups/industries (making up 31% of imports and 32% of exports in the Japanese market) which are statistically significant, including: live animals and products from live animals (SC02); textile materials and textile products (SC11); stone, cement and glass products (SC13); base metals and metal products (SC15); optical, photographic, cinematographic tools and equipment... (SC18); works of art, collectors' pieces and antiques (SC21). Of which, the commodity groups/industries that have positive signs are the SC11, SC15 and SC21. As for those concluded to be statistically significant by the income coefficient of Vietnam, they – including leather and leather products (SC08), wood and products of wood (SC09), stone and plaster products (SC13), means of transport (SC17), and miscellaneous manufactured articles (SC20) – only occupy 10% of imports and 18% of exports of Vietnam in the Japanese market.

The coefficient of the variable denoting exchange rate in the aggregate model (**Sctotal**) of Japan is not statistically significant, implying that exchange rate does not affect the total trade balance between Vietnam and Japan.

In general, from the results of the ARDL model, the responses of trade balance between Vietnam and Japan to changes in exchange rates only appear in 6 commodity groups/industries which account for 24% of imports and 38% of exports of Vietnam in this market. However, looking at the model that measure the impacts of exchange rate on Vietnam's total trade balance (denoted by the dependent variable **Sctotal**) with Japan, it is possible to conclude that exchange rate is not sensitive to trade balance in the case of Vietnam. The results justified Baek (2013)'s conclusion, saying that the use of aggregate data will cause bias in the estimates of the coefficients. Apparently, it is not reasonable to conclude how differently the exchange rate affects the trade balance of different partners and how it affects different commodity groups/industries just by looking at the results of the aggregate model.

4.3. Estimation results of short-run coefficients in the ARDL models

Table 6 (see Appendix) presents the short-run coefficient estimate of the exchange rate variable in the models of the three partners. The exchange rate is considered to have a short-term impact on a commodity group/industry's trade balance if at least one short-run coefficient is statistically significant.

Results showed that there are 8 commodity groups/industries that have at least one statistically significant short-run coefficient. These groups make up 33% of imports and 40% of exports of Vietnam in this market, including SC02 (vegetable products), prepared foodstuffs and beverages (SC04), chemical products (SC06), wood and products of wood (SC09), textile materials and textile products (SC11), stone and plaster products (SC13), base metals and metal products (SC15), works of art… (SC21). Most of the coefficients have negative signs at lag 2 and reverse the signs at lag 4.

The J-curve effect

The impacts of exchange rate on the trade balance of an industry/a commodity group is considered to yield a J-curve effect when the currency depreciates. In particular, the trade balance will deteriorate in the short term and improve in the long term. Thus, according to the previous research, a commodity group/industry is likely to experience the J-curve effect if the short-run coefficient of the exchange rate variable has a negative sign while the long-run coefficient has a positive sign. However, the estimation results for the short-run and long-run coefficients of the exchange rate variable showed that the J-curve theory is not applicable to the case of Vietnam and Japan.

4.5. Estimation results of long-run coefficients in the NARDL models

Table 2 presents the long-run coefficient estimates of the NARDL model. As shown in Section 1, the NARDL model aims to test trade balance's response to exchange rate movements in two cases: when the currency depreciates and when the currency appreciates. The theory of the asymmetric responses of trade balance to exchange rate changes suggests that producers will respond quickly to fluctuations in markets to meet export demand. However, when the currency appreciates, exporters will react more slowly to changes in exchange rate due to market share constraints... Therefore, it is expected that the impacts of exchange rate on trade balance in case of currency devaluation will be larger compared with the case of currency appreciation.

In this study, NEG or a negative value of "ΔLER" denotes the appreciation of the VND while POS specifies the depreciation of the VND. Asymmetric reactions will not occur if the coefficients of NEG and POS have the same sign and equal in magnitude.

Table 2: Estimation results of long-run coefficients in the NARDL models

Product code	**POS**		**NEG**		**INDVN**		**INDCN**	
Japan								
SC01	-1.3819	(0.8833)	0.7183*	(0.4258)	1.2183**	(0.6129)	-0.3472	(1.1886)
SC02	-1.7599	(1.8807)	-2.4403***	(0.8319)	-1.3130	(1.1013)	1.1542	(2.7931)
SC04	4.8406**	(2.0263)	1.8820*	(0.9928)	-2.6498***	(0.9370)	0.9816	(2.3449)

SC05	5.5089*	(3.2712)	2.4853	(1.5754)	-1.6377	(1.9831)	4.1585	(4.6704)
SC06	0.5406	(0.6328)	-0.3279	(0.2917)	-0.8015**	(0.3792)	2.5403**	(1.2008)
SC07	0.6520	(0.4323)	-0.8183***	(0.1854)	-0.8350***	(0.2605)	1.3210*	(0.6867)
SC08	-3.1442**	(1.3367)	-2.4172***	(0.6326)	0.2535	(0.8206)	-0.3229	(1.6184)
SC09	0.8367	(1.2116)	-1.0388*	(0.5574)	-1.8273**	(0.7585)	5.2695**	(2.2727)
SC10	1.6186***	(0.5997)	0.6145**	(0.2783)	-0.7077*	(0.3584)	-0.7886	(0.7610)
SC11	0.1279	(0.1023)	-0.5706***	(0.0509)	-0.1585**	(0.0717)	-0.1381	(0.1203)
SC12	1.7006***	(0.3821)	-0.3682**	(0.1770)	-1.1905***	(0.2275)	-0.3968	(0.4855)
SC13	-1.0499***	(0.2980)	-1.4373***	(0.1330)	-1.0095***	(0.1843)	2.0154***	(0.3950)
SC14	-1.0599*	(0.5960)	-0.0387	(0.2823)	1.2108***	(0.4038)	-0.2790	(0.8412)
SC15	0.4388	(0.3835)	-0.6822***	(0.1766)	-0.0966	(0.2196)	1.5682***	(0.5650)
SC16	0.1964	(0.4283)	0.1183	(0.1966)	0.1257	(0.3251)	-0.4802	(0.5596)
SC17	0.1871	(1.9038)	0.0722	(0.8300)	0.3208	(1.1378)	7.6848**	(3.6990)
SC18	0.9102**	(0.3816)	-0.0567	(0.1824)	-1.0795***	(0.2307)	-0.5476	(0.4830)
SC20	-0.8942***	(0.2773)	-0.2375*	(0.1276)	0.2469	(0.1733)	-1.1858***	(0.3518)
SC21	2.9854***	(0.5978)	2.0845***	(0.2668)	0.1272	(0.3464)	1.5569*	(0.8813)
SCtotal	1.2032*	(0.7186)	0.1449	(0.3017)	-0.5778	(0.4037)	1.9493*	(1.1385)

Source: Author's calculations.

*Note: 1. * Indicates significance at the 10% level , ** at the 5% level, and *** at the 1% level*

2. Numbers inside parentheses are the standard deviation of the coefficients

Results of the NARDL models pointed out that there are 15 commodity groups/ industries (accounting for 40% of imports and 60% of exports between Vietnam and Japan) which are sensitive to exchange rate changes including 6 commodity groups/industries that are specified by the ARDL models: vegetable products (S02), leather and leather products (S08), textile materials and textile products (S11), stone and glass products (S13), base metals and metal products (S15), works of art, collectors' pieces and antiques (S21). 9 other commodity groups/industries pointed out by the NARDL models include: live animals and products from live animals (SC01), prepared foodstuffs and beverages (SC04), mineral products (SC05), plastic and plastic products (SCN07), paper and paper products (SC10), footwear (SC12), stone and plaster products… (SC13), precious stones and precious metals (SC14), base metals and metal products (SC15), optical, photographic, cinematographic tools and equipment... (SC18), miscellaneous manufactured articles (SC20), works of art, collectors' pieces and antiques (SC21). There is a notable difference between the ARDL model and the NARDL model. In the NARDL model, trade balance is found to be more sensitive to exchange rate movements than in the ARDL model. This finding is consistent with many previous studies, pointing at the problem of bias that encounters previous works when assuming that the impacts of exchange rate on trade balance is always symmetrical (Bahmani-Oskooee and Baek, 2016; Arize et al., 2017). Clearly, without the adoption of the non-linear regression model (NARDL), these commodity groups/industries might be mistaken that their real exchange rate coefficients were not statistically significant. Or in other words, their trade balance did not respond to the change of exchange rate.

The coefficient results of SC01 showed that exchange rate only affects the trade balance of the group. When the VND appreciates by 1 per cent against the JPY, the trade balance deteriorates by 0.72%. SC02, SC07, SC09, SC11 and SC15 also send out asymmetric responses to the appreciation of the VND but the trade balance of these industries improve by 0.5-2.4%. In case of VND devaluation, the trade balance of SC05 and SC18 respond positively to the change of exchange rate. If, the real exchange rate RER increases by 1%, the trade balance of these industries will increase by 0.9-5.5%. The SC04, SC10 and SC21 commodity groups/industries are found to have symmetrical reactions, i.e. if exchange rate increases (or VND depreciation), trade balance will improve by 1.6-4.8%; if exchange rate decreases (or VND appreciation) trade balance will get worsened by 0.6-2%. In contrast, the SC08, and SC13 groups also show symmetrical responses but their trade balance become worsened when the VND depreciates and improve when the VND appreciates. Athought SC20 also have same positive sign for NEG and POS, but the Wald test (see table 5) suggests that the deprecitation and appreciation of the VND will exert long-run asymmetrical effects on trade balance. The SC12 group reacts to both the devaluation and the appreciation of the VND and the trade balance improves in both cases. However, the absolute magnitude of the NEG and POS coefficients implies that trade balance might have a stronger reaction to exchange rate in case of currency appreciation.

Concerning the aggregate model with the variable **SCtotal** denoting product code, the results indicated that exchange rate does affect the trade balance between Vietnam and Japan in case of VND depreciation. If the VND depreciates by 1%, Vietnam's trade balance with Japan will improve by 1.2%. In case of VND appreciation, the trade balance is not affected.

In general, the results of the NARDL model have again emphasized the limitations of the ARDL model's approach with its one-size-fits-all assumption saying that the effects of exchange rate on trade balance are always symmetrical. Results showed that the impacts of exchange rate are found to be asymmetric in many commodity groups/industries. The conclusions of the NARDL model confirmed that a lot of commodity groups/industries have witnessed the effects of exchange rate on trade balance with statistically significant POS and NEG coefficients. Meanwhile, if we looked at the results yielded from the ARDL model, these commodity groups/industries are found to not respond to exchange rate changes. Among the 16 commodity groups/industries that have sensitive trade balance to changes in exchange rate, 9 groups/industries produce asymmetric responses. On a side note, the devaluation of the VND does not necessarily mean that the trade balance will improve. Only 6 out of 10 groups/industries have positive POS coefficients or the trade balance will improve when the VND depreciates. In case of VND appreciation, there are 13 affected commodity groups/industries (as their coefficients of NEG are statistically significant). Only 4 groups/industries suffer from deteriorating trade balance. In contrast, the results of the model run on aggregate trade data showed that exchange rate only affects trade balance in case of VND depreciation and benefits Vietnam as it will improve the country's trade balance.

4.6. Estimation results of short-run coefficients in the NARDL models

Similarly, the short-run coefficient estimates of the NARDL models are presented in Table 7 (See Appendix). The results of the Wald test statistic (See table 5 as Wald_S) indicate that we can reject the null hypothesis of symmetry in the short-run for 11 commodity groups. Of which, commodity groups/industries that are sensitive to exchange rate when the VND depreciates include: SC02, SC08, SC10, SC12, SC18 and SC20. Meanwhile, SC05, SC06, SC10, SC11, SC12, SC15, SC18, and SC20 are sensitive to exchange rate when the VND appreciates. Overall, considering the estimation results of the short-term coefficients included in the NARDL models, it is apparent that using the NARDL model can detect more commodity groups/industries that respond to exchange rate than using the ARDL model.

The J-curve effect

In the NARDL model, an industry is considered to have the J-curve effect when there is at least a negative short-term coefficient, provided that the short-term coefficients at the previous lag are not positive and statistically significant – or all coefficients are not statistically significant – plus the long-term coefficient of POS is positive and statistically significant. According to the results of the models, the J-curve effect is found in SC04, SC05 and SC21. However, the J-curve effect is not spotted in the Sctotal aggregate model.

In summary, the results of the models show that not much evidence was found in the case of trade relations between Vietnam and Japan to support the theory of the J-curve effect.

5. Conclusion and policy recommendations

The paper exclusively employs the linear ARDL and non-linear ARDL (NARDL) models to examine the trade relations between Vietnam and Japan in each industry (21 industries based on the classification of goods specified the Harmonized System – HS). In particular, the paper seeks to overcome the shortcomings of previous works in assessing the relationship between trade balance and exchange rate in Vietnam by: (1) using industry data to address any limitations raised by the utilisation of aggregate data, and (2) employing a non-linear model to avoid bias when assuming that trade balance produces symmetrical responses after the currency depreciates or appreciates.

Given the estimation results of the short-term and long-term coefficients included in the model, several conclusions can be drawn as follows:

First, the estimation results of the ARDL and NARDL models for all industries revealed a degree of bias to the regression estimates when using aggregate data for the asymmetric approach. Therefore, the author's approach of using the NARLD model with industry-level data would provide a more comprehensive and complete picture of the effects of exchange rate changes on Vietnam's trade balance.

Second, the theory on the J-curve effect was not supported by the estimation results of the model examining the relationship between Vietnam-Japan trade balance and the exchange rate. Results from models using industry-specific data implied that only few industries have experienced the J-curve effect while the models employing aggregate data did not find any signs of the J-curve effect.

Third, Japan's income (proxied by the industrial production index) had a positive impact on Vietnam-Japan trade balance, whereas Vietnam's income did not.

Fourth, the paper shows that trade balance of all industries are relatively sensitive to exchange rate (16/19 industries). Furthermore, the industries' trade balance respond differently to exchange rate's changes. However, the industries that show significant responses do not contribute a large proportion in bilateral trade turnover, in fact only affecting roughly 60% of imports and 40% of exports between Vietnam and Japan. Results from the NARDL models with aggregate data indicated that, when VND depreciates, Vietnam's trade balance with Japan will improve. In the case where VND appreciates, the trade balance does not respond to changes in exchange rate. Therefore, the exchange rate seems to be an effective tool in improving Vietnam's trade balance in the Japanese market.

Thus, results implied that exchange rate really affects the trade balance between Vietnam and Japan. Nevertheless, the magnitude of such impacts depend on each industry. Given the conclusions above, it is plausible to consider exchange rate an effective tool to stimulate exports and improve Vietnam's trade balance. However, the use of exchange rate should be well-thought-out based on different priority targets and the coordination between different policies. For example, in view of targets relating to inflation, foreign debts or the stabilization of the currency market, a depreciation of VND is expected to exert negative effects on these targets.

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APPENDIX

Table 3: HS Classification by section (21 sections)

Product code	Name of product
SC01	Live animals; products from animals
SC02	Vegetable products
SC03	Animal or vegetable fats and oils and their cleavage products; prepared edible fats; animal or vegetable waxes
SC04	Prepared foodstuffs; beverages, spirits and vinegar; tobacco and manufactured tobacco substitutes
SC05	Mineral products
SC06	Products of the chemical or allied industries
SC07	Plastics and articles thereof; rubber and articles thereof
SC08	Raw hides and skins, leather, furskins and articles thereof; saddlery and harness; travel goods, handbags and similar containers; articles of animal gut (other than silk-worm gut)
SC09	Wood and articles of wood; wood charcoal; cork and articles of cork; manufactures of straw, of esparto or of other plaiting materials; basketware and wickerwork
SC10	Pulp of wood or of other fibrous cellulosic material; recovered (waste and scrap) paper or paperboard; paper and paperboard and articles thereof
SC11	Textiles and textile articles
SC12	Footwear, headgear, umbrellas, sun umbrellas, walking-sticks, seat-sticks, whips, riding-crops and parts thereof; prepared feathers and articles made therewith; artificial flowers; articles of human hair
SC13	Articles of stone, plaster, cement, asbestos, mica or similar materials; ceramic products; glass and glassware

SC14	Natural or cultured pearls, precious or semi-precious stones, precious metals, metals clad with precious metal and articles thereof; imitation jewellery; coin
SC15	Base metals and articles of base metal
SC16	Machinery and mechanical appliances; electrical equipment; parts thereof; sound recorders and reproducers, television image and sound recorders and reproducers, and parts and accessories of such articles
SC17	Vehicles, aircraft, vessels and associated
SC18	Optical, photographic, cinematographic, measuring, checking, precision, medical or surgical instruments and apparatus; clocks and watches; musical instruments; parts and accessories thereof
SC19	Arms and ammunition; parts and accessories thereof
SC20	Miscellaneous manufactured articles
SC21	Works of art, collectors' pieces and antiques

Table 4: Results of the bound tests and diagnostic tests for the ARDL models

Product	F	ECM(t-1)	LM	RESET	HSK test	CUSUM	CUSUMSQ	R2
Japan								
sc01	5.502**	-0.3265***	6.836*	3.828**	15.23***	S	S	0.3186
sc02	5.945***	-0.3203***	0.397	0.455	4.997**	S	S	0.3286
sc04	4.306*	-0.1577*	0.833	0.458	1.713	S	S	0.4951
sc05	4.007*	-0.4125***	3.22	1.192	0.884	S	S	0.4098
sc06	2.764	-0.2110**	2.366	2.944	0.105	S	US	0.4907
sc07	1.573	-0.1310	2.67	0.666	0.0898	S	US	0.5341
sc08	5.876***	-0.2975***	4.613	1.653	3.499*	S	S	0.2137
sc09	4.122*	-0.3384***	2.663	0.431	5.052*	S	S	0.6923
sc10	3.93*	-0.2714***	3.637	0.295	0.231	S	US	0.3532
sc11	2.616	-0.4016***	3.649	2.967	2.969	S	US	0.6603
sc12	3.047	-0.3777***	4.686	1.160	0.543	US	S	0.5351
sc13	11.336***	-1.2724***	3.644	1.115	1.043	S	S	0.5253
sc14	24.126***	-0.8611***	22.13**	1.829	86.42***	S	US	0.4727
sc15	10.699***	-0.4938***	0.577	3.943**	0.0359	S	S	0.3016
sc16	3.521	-0.4763***	3.22	2.400*	0.152	S	US	0.5666

sc17	3.610	-0.1950***	1.249	0.370	0.942	S	S	0.2991
sc18	5.952***	-0.2912***	4.065	1.413	0.123	S	S	0.5246
sc20	3.737*	-0.4574***	2.247	0.724	0.997	S	S	0.5706
sc21	8.786***	-0.5652***	3.634	3.311**	0.189	S	S	0.4331
Total	2.895	-0.2078**	4.553	1.512	3.699*	S	S	0.5524

Note: 1. The upper bound critical value of the F-test for cointegration is 3,52 for the 10% level of significance and 5.06 for the 1% level. See Pesaran et al. (2001, Table CI, CaseV, p. 301.)

*2. * Indicates significance at the 10% level , ** at the 5% level, and *** at the 1% level*

Table 5: Results of the bound tests and diagnostic tests for the NARDL models

Product	F	ECM(t-1)	LM	RESET	HSK test	Wald_l	Wald_s	CUSUM	CUSUMSQ	R2
sc01	5.746	-0.4577***	2.205	0.52	2.796	8.41***	0.21	S	US	0.396
sc02	5.194	-0.3035***	2.715	1.442	2.137	0.20	3.92**	S	US	0.3698
sc04	4.319	-0.2204**	2.193	0.195	0.553	4.95**	0.31	S	S	0.5835
sc05	4.417	-0.4686***	5.758	1.404	2.605	1.38	4.78**	S	S	0.5339
sc06	5.445	-0.3469***	3.133	2.136	1.132	2.91*	6.49**	S	US	0.6051
sc07	5.354	-0.3876***	6.439	2.372	0.161	18.22***	2.28			0.5977
sc08	6.499	-0.3359***	6.311	1.547	0.126	**0.48**	9.56***	S	US	0.2653
sc09	2.84	-0.4311**	6.392	1.343	1.528	3.7*	0.36	S	US	0.6454
sc10	4.403	-0.3642***	2.973	0.671	2.502	4.43**	3.35*	S	S	0.3721
sc11	42.647	-1.2895***	3.233	0.0811	0.0892	69.47***	53.94***	S	NS	0.6828
sc12	27.425	-1.3298***	1.213	2.253	0.0293	46.49***	32.02**	US	US	0.5617
sc13	9.691	-1.1350***	5.984	5.059**	4.536	**2.57**	2.64	S	US	0.5411
sc14	13.216	-0.9884***	3.971	3.593	33.63**	4.42**	0.19	S	US	0.6472
sc15	10.602	-0.6418***	1.667	1.169	0.624	14.10***	3.45*	S	S	0.4325
sc16	2.812	-0.4725***	3.14	0.846	0.145	0.04	0.05	S	US	0.5668
sc17	2.534	-0.1704***	3.729	3.82*	0.0825	0.006	8.47***	S	S	0.4432
sc18	6.345	-0.5219***	4.761	2.561	3.439	10.92***	4.82**	S	S	0.5803
sc20	6.434	-0.6629***	7.104	1.988	0.991	8.58***	7.28***	S	S	0.5893
sc21	13.484	-0.7344***	2.813	1.889	0.316	3.58*	1.32	s	S	0.4586
Total	2.684	-0.2618***	3.558	1.729	0.27	3.59*	4.19**	S	S	0.569

Note: *1. The upper bound critical value of the F-test for cointegration is 3.52 for the 10% level of significance and 5.06 for the 1% level. See Pesaran et al. (2001, Table CI, CaseV, p. 301.)*

*2. * Indicates significance at the 10% level , ** at the 5% level, and *** at the 1% level*

Table 6: Estimation of short-run coefficient in the ARDL models

ABLES	D.lrer		LD.lrer		L2D.lrer		L3D.lrer		L4D.lrer		L5D.lrer		Constant		Observations	R-squared
SC01	0.3023	(0.2030)											-0.6248	(2.4840)	117	0.3186
SC02	1.5396	(1.3487)	-2.5793*	(1.3903)	1.2516	(1.4002)	-1.0674	(1.3870)	3.2497**	(1.3647)	-2.1704	(1.3492)	8.3859**	(4.0611)	114	0.3286
SC04	0.1132	(0.8719)	-1.1435	(0.8858)	0.3034	(0.9079)	-0.9949	(0.8923)	-2.3611***	(0.8894)			-4.2553*	(2.3353)	114	0.4951
SC05	0.5119	(0.7149)											9.7409	(9.6712)	117	0.4098
SC06	0.1086	(0.6408)	-1.3390**	(0.6378)									-1.4395	(1.5888)	114	0.4907
SC07	0.7272	(0.4484)	-0.1220	(0.4288)	0.3830	(0.4309)	-0.7324*	(0.4374)	-0.9795**	(0.4305)			-1.4457	(1.1583)	114	0.5341
SC08	1.6964	(1.1682)	1.5955	(1.2287)									7.3226**	(2.9446)	118	0.2137
SC09	-0.7706	(1.2853)	-2.8824**	(1.3157)	-0.0119	(1.3535)	-1.4099	(1.3261)	3.2053**	(1.3215)	-3.9266***	(1.2963)	-4.4661	(3.5937)	114	0.6923
SC10	0.1655	(0.1081)											0.7793	(1.3978)	114	0.3532
SC11	-0.7187*	(0.4119)	-0.9626**	(0.4229)									2.5930**	(1.0972)	114	0.6603
SC12	-0.3274	(0.2195)											6.7334**	(3.1818)	114	0.5351
SC13	-1.8486***	(0.3280)											3.7641	(2.6054)	114	0.5253
SC14	-0.0093	(0.2998)											0.5883	(4.0764)	117	0.4727
SC15	-0.3385***	(0.1256)											-2.4062	(1.6439)	114	0.3016
SC16	0.0496	(0.0967)											0.0592	(1.3046)	114	0.5666
SC17	-0.0308	(0.1358)											-3.7809*	(2.1251)	114	0.2991
SC18	-0.0703	(0.0882)											2.9965**	(1.2373)	114	0.5246
SC20	-0.0873	(0.0866)											4.1099***	(1.4901)	114	0.5706

SC21	1.1412***	(0.2638)											-11.6202***	(3.3154)	114	0.4331
SCtotal	0.0168	(0.0748)											-2.3043**	(1.0970)	114	0.5524

*Note: 1. * Indicates significance at the 10% level , ** at the 5% level, and *** at the 1% level*

2. Numbers inside parentheses are the standard deviation of the coefficients

Table 7: Estimation of short-run coefficients in the NARDL models

	D.lrer_p		LD.lrer_p		L2D.lrer_p		L3D.lrer_p		L4D.lrer_p		D.lrer_n		LD.lrer_n		L2D.lrer_n		L3D.lrer_n		L4D.lrer_n		L5D.lrer_n	
SCN01	-1.4670	(2.5382)	1.3702	(2.6014)	0.6561	(2.8221)					1.5806	(1.6938)	-0.8967	(1.7433)	2.6599	(1.6971)						
SCN02	2.6979	(3.3165)	-0.0996	(3.1545)	7.7051**	(3.4013)					1.4402	(2.1406)	-3.7501*	(2.1742)	-1.8929	(2.1840)	-1.6667	(1.9478)	4.8826**	(1.9290)	-3.8554**	(1.9080)
SCN04	1.9186	(1.9952)	2.9605	(1.9423)	-3.8541*	(2.0888)	-1.3443	(2.1176)	-6.3628***	(1.9102)	-0.4087	(1.3354)	-3.9021***	(1.3486)	2.6566*	(1.3914)	-2.0512	(1.3670)				
SCN05	2.5816	(1.6026)									9.2575	(5.5768)	-6.9226	(5.7963)	1.1087	(5.7804)	-9.8421*	(5.5986)	-15.0759***	(5.5621)		
SCN06	0.1875	(0.2351)									0.3625	(0.8371)	-2.6638***	(0.8636)	1.3761	(0.8977)	-2.3239***	(0.8582)				
SCN07	0.2078	(0.9482)	1.6853*	(0.9355)	0.3458	(0.9034)	-2.0592**	(0.8975)	-2.5297***	(0.9178)	1.0675	(0.6482)	-0.9635	(0.6173)								
SCN08	-1.0561**	(0.4358)									2.1545	(1.6145)	2.0698	(1.6398)	2.9105*	(1.6391)						
SCN09	-4.0957	(3.2253)									1.7635	(2.2227)	-2.9568	(1.9745)								
SCN10	0.5896**	(0.2662)									0.2238*	(0.1146)										
SCN11	0.1649	(0.1321)									-0.7357***	(0.0820)										
SCN12	1.9302***	(0.4784)									-0.4180**	(0.2026)										
SCN13	1.2146	(3.6770)	1.2306	(3.7702)	-8.7054**	(4.0177)					-1.4387	(2.4590)	-1.0766	(2.5159)	2.5874	(2.4464)						
SCN15	0.2816	(0.2482)									0.1052	(0.8816)	1.5758*	(0.8978)	-0.7101	(0.9102)	0.6773	(0.8860)	1.6741*	(0.8706)		
SCN16	0.0928	(0.2017)									0.0559	(0.0979)										
SCN18	0.4750*	(0.2617)									0.6133	(0.6985)	0.3194	(0.7099)	1.7874**	(0.6957)						
SCN20	-0.5927***	(0.2041)									-0.1574*	(0.0884)										
SCN21	-1.1930	(2.3930)									1.5308***	(0.2696)										
SCNtotal	0.3150*	(0.1628)									0.0379	(0.0747)										

*Note: 1. * Indicates significance at the 10% level , ** at the 5% level, and *** at the 1% level*

2. Numbers inside parentheses are the standard deviation of the coefficients