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Abstract

Bilateral trade balance always deserves particular interest of policy makers and economists. In this paper, we examined the asymmetric and symmetric effect of real exchange rate on bilateral trade balance between Vietnam and the US at both aggregated and disaggregated commodity levels. We employed both Linear Autoregressive Distributed Lag (ARDL) and Non-linear ARDL (NARDL) models to a dataset spanning over 18 years. We found that (i) both symmetry and asymmetry of real exchange rates are not significant to explain the total trade balance between Vietnam and the United States; (ii) unlike the insignificant effect on the aggregated level, the empirical evidence at the disaggregated level is mixed and dependent on product category. Our findings reveal that (iii) the claim of unfair trade by using exchange rate from the US Treasury is unclear from our estimations; and (iv) a depreciation of USD (i.e. appreciation of VND) leads the long-run US's trade balance will improve for 10 commodities, and whereas an appreciation of USD (depreciation of VND), long-run trade balance will improve for 11 commodities. The results suggest that only a number of specific industries will benefit from USD appreciation or depreciation.

Keywords: asymmetry exchange rate; trade balance; ARDL; NARDL;

JEL Classification: F14, C22, F40

1 Introduction

International trade plays an important role for economic growth and has deserved particular interest of policy makers and economists. Singh (2010) reviewed different international trade related issues, such as the Granger causality between trade and economic growth, and the impact of trade openness to growth. The hypothesis of export-led-growth was reviewed in Edwards (1993, 1998), Frankel and Romer (1999), Lopez (2005), Wagner (2007). Meanwhile, some studies focus on the hypothesis of trade openness in supporting the productivity and growth (Ewards, 1998; Alcala and Ciccone, 2004). Several studies demonstrate that international trade facilitates economic growth through the channel of investment and capital accumulation (Frankel and Romer, 1996; Wacziarg, 2001).

Vietnam has been considered one of the most rapid growth economies in the world during the last several decades (6.45% on average in the period 2000-2018[1]), partly due to its increasing external trade. Inflation is well controlled for from the high level of 7.85% on average of period 2000-2013, to moderate level of 3.1% during the last five years over 2014-2018. During this period, in order to foster the economic growth, Vietnam has issued the Law of Foreign Direct Investment to welcome foreign investors, and has signed and participated in many multi- and bilateral trade agreements such as the Free Trade Agreements (FTA) (about dozen FTA). As a result, the total import and export value of Vietnam is expanding from 30 billion USD in 2000 to a new record of 470 billion USD in 2018. Currently, the most important trade partner of Vietnam is the United Sates. The bilateral relations between the two countries were normalized in 1995 and the US-Vietnam bilateral trade agreement was signed in 2000, paving the way for expanding trades of an increasing number and quantity of many commodities. Vietnam has maintained an annual trade surplus with the United States during a long period (Figure 1). The total import and export of Vietnam to the US reached more than US$ 60 billion in 2017, which accounts for about 12.8% of Vietnam's total trade. The United States is the largest exporting partner and the second largest importing partner of Vietnam. Meanwhile, according to US's Treasury report on macroeconomic and foreign exchange policies of major trading partners of the United States (May 2019), Vietnam is ranked 6th among countries with the largest trade relations with the US. The trade items with the US are very diverse. The ten main traded products include the articles of apparel and clothing, footwear, telecommunication equipment, electrical machinery, furniture, office machine, fish, vegetables and fruit, miscellaneous manufactured articles, and travel goods and handbags (see Table 1).

(Insert Figure 1 here)

Figure 1: Export, import and trade balance between Vietnam and the US (billion USD, current price)

Source: Datastream Refinitiv, access date: March 12, 2019.

However, the US's Treasury report in May 2019 also added Vietnam to a watch list of countries for possible currency manipulation. The trade surplus of Vietnam with the US and currency manipulation watching list are the main reasons for President Donald Trump to claim that

[1] According to IMF database

"Vietnam is almost the single-worst abuser of everybody"[2] and unfair trade partner of the US, and then US's Trade Representative, Robert Lighthizer said that "has been clear with Vietnam that it has to take action to reduce the unsustainable trade deficit"[3] between the two countries.

One of the factors that are commonly supposed in the literature to have significant effects on trade balance is the devaluation or depreciation of the currency, which results in changes in real exchange rate. The Marshall Lerner condition (Lerner, 1944) demonstrates that currency devaluation or depreciation will improve the trade balance if the total elasticity of imports and exports is greater than one. Even though the relationship between exchange rate and trade balance in Vietnam or the US has been investigated separately in several researches, however, the bilateral relationship between two countries is an interesting topic which will be further examined in this paper. Firstly, the US is the most important trading partner for the Vietnam economy, and to our best knowledge, this paper will be the first one investigating this phenomenon. Secondly, most of the previous studies mainly focus on Vietnam's total trade balance (or trade), but do not provide a deep and depth analysis on the impact of exchange rate to trade balance at disaggregated level. Thirdly, the US has claimed Vietnam being unfair in trade with them in the US treasury report by citing an External Balance Assessment (EBA) methodology from IMF (2018). It shows that Vietnamese currency is undervalued 7%, however, it also notes that Vietnam is not included in the sample for current account gap calculation,[4] and the poor result in the fitness of the model has been admitted as well. Lastly, most of previous researches about the relationship between Vietnam's trade balance and exchange rate are performed by linear models. Hence, it could not provide a comprehensive view on the inconstant elasticity of exchange rate on trade balance.

Our study thus contributes to filling these gaps. We use trade data between Vietnam and the US over a long period of 18 years (2000Q4-2018Q4) and examine at both aggregated level and disaggregated level (commodity level). We apply the novel approaches of Non-linear ARDL (NARDL) model by Shin et al (2014) and linear ARDL to investigate the (a)symmetry of exchange rate on bilateral trade balance between the US and Vietnam. Our findings are expected to shed light on what industries benefit from depreciation or appreciation of USD.

The remainder of this paper is organized as follows. Section 2 reviews the relationship between exchange rate and trade balance. Section 3 describes the data and methods. Section 4 presents and discusses the findings. Section 5 concludes.

2 Literature Review

The relationship between exchange rate and trade balance has always been a highly debated topic among academics over the past decades. Nowadays, several empirical studies have been carried out based on developments in macroeconomic and econometric analysis. Despite the

[2] An interview with Fox Business Network on 26/6/2019

[3] Lighthizer relies to the US Senate Finance Committee on 29/7/2019.

[4] Recall that a Real Effective Exchange Rate (REER) gap measures the overvaluation or undervaluation of currency in EBA methodology. REER gap is computed by ratio of current account gap to semi elasticity of current account.

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.

On the one hand, the devaluation of the dollar would improve the U.S. trade balance (Thorbecke, 2018; Narayan, 2006; Bahmani-Oskooee and Wang, 2007;). Thorbecke (2018) studiese the impact of exchange rate and US's trade (import and export) between the US and its main trade partners including China and another group of developed countries of Germany, Japan, South Korea and Switzerland over the period of 1992 to 2017. By using DOLS estimation and focusing on manufacturing industries, this study shows that exchange rates on global export volume of fourteen goods categories are negative and significant at least the 10%, indicating that 10% appreciation of the dollar will reduce the US's export volume. In addition, the elasticity of U.S. export for automobiles, toys, wood, aluminum, iron, steel, and other goods are very high and excess to unity. Meanwhile, exchange rates on global import are positive and significant for only twelve goods categories. By separating two groups, one with China and the other one with four developed countries, the elasticity of US import from China is high for footwear, radios, sports equipment, lamps, and watches. High import elasticity is also found in 4 developed countries for manufacturing industries of electro thermal appliances, radios, furniture, lamps, miscellaneous manufacturing, aluminum, automobiles, plastics, and other categories.

Narayan (2006), Bahmani-Oskooee and Wang (2007), Koo and Zhuang (2007) focus on impact of real exchange rate on bilateral trade balance between the US and China. Narayan (2006) use monthly aggregated data of trade balance in the period from November 1979 to September 2002 by applying the ARDL model. The result points out that a 1% real depreciation of Yuan (or an appreciation of Dollar) will improve the China's trade balance with the US by 1.2%. Bahmani-Oskooee and Wang (2007) use an error-correction and cointegration model to investigate the relationship between real exchange rate and disaggregated trade balance of 88 commodities over the annual period of 1978–2002. They find that in the long-run a real appreciation of US dollar (or depreciation of Yuan) will worsen the trade balance between US and China for 40 commodities.

However, Lee *et al.* (2006) simulate the impact of Asian currencies on the US trade balance. They find no effect of Asian currencies (Vietnam is not in the sample) on the US trade balance. Moreover, Chiu *et al.* (2010) study the impact of real exchange rate on bilateral trade balance of the U.S. and 97 trading partners for the period 1973– 2006 by using a Fully Modified OLS estimation. Their findings show that the devaluation of the US dollar improves bilateral trade balance with 37 trading partners including China, but makes worsen it with 13 trading partners.

On the other hand, empirical results for the hypothesis of VND depreciation will improve Vietnam's trade balance are mixed. Pham (2014), Nguyen and Trinh (2019) find that a real depreciation of VND will improve the Vietnam's trade balance in the long-run. However, Hoang (2013) shows an inverted result with Pham (2014), Nguyen and Trinh (2019), i.e. a real

depreciation VND worsens the trade balance in long-run. In addition, Pham (2014) also indicates a real depreciation of VND will deteriorate the trade balance in short-run.

In more detail, Hoang (2013) uses a reduced-form VAR model, over monthly period 1995.M1-2012.M12. His result implies that a positive shock of the real exchange rate (i.e. real depreciation VND) worsens significantly the trade balance after 2 months until the 11th month. Pham (2014) applies ARDL model over the quarterly period 2000Q1 to 2010Q4 to find that an appreciation of VND deteriorates trade balance in a long-run, but at a limited extent. In a short-run, a depreciation of VND has a negative effect on trade balance. She argues that a lack of subsidiary industries of imported material for export production is an important reason why VND appreciation has this negative effect on trade balance. In addition, Nguyen and Trinh (2019) also use the ARDL model and extend the data for a quarterly period 2000.Q1-2014Q4 and find similar same results. However, Hoang (2016) finds the exchange rate movement is not significant in import and export by using a structural VAR and Vector Error correction model over period 2004-2015 (monthly data). Her explanation is nearly the same as in Pham (2014). Phan and Jeong (2015) examine the effect of real exchange rate on bilateral trade balance of Vietnam and its sixteen trading partners over the period 1999-2012, by using panel Fully Modified OLS and Dynamic OLS estimation. Their findings suggest that Vietnam's trade balance can be improved by re-structuring the economy rather than devaluating currency in the long-run. Tran (2019) and Pham *et al.* (2019) examine the impacts of exchange rate on bilateral trade balance between Vietnam-Japan and Vietnam-China in aggregated level and in industry level, by using linear and nonlinear ARDL models. In aggregate level, it exists a positive relationship between exchange rate on Vietnam-Japan trade balance in case of currency depreciation, whereas currency appreciation has no impact. Whereas there is no statistical linkage evidence the exchange rate and trade (export and import) for bilateral trade balance between Vietnam and China.

Even though some studies have examined the relationship between exchange rate and trade balance (the US or Vietnam), there are a number issues that need further investigation. First, we will investigate of impact exchange rate on bilateral trade balance between Vietnam and the most important trading partner (the US). Second, we will analyze this relationship for aggregated level and disaggregated level. Third, we will employ a recent novel methodology of ARDL and NARDL to perform constant and inconstant elasticity of exchange rate on bilateral trade balance between the US and Vietnam.

3 Data and Methods

3.1 Data

In this paper, we use quarterly data over 18 years from 2000.Q4 to 2018.Q4[5]. Exports and Imports are from US Census Bureau, and are classified by 2-digit SITC (Standard International Trade Classification). The US's GDP and Vietnam's GDP are in constant price (2010=100), from the US Bureau of Economic Analysis and the General Statistic Office of Vietnam. Nominal

[5]We choose this period due to Vietnam's GDP is available from 2000Q4, and the beginning of the Bilateral Trade Agreement between the US and Vietnam.

exchange rate is from the State Bank of Vietnam. The consumer price index of US and Vietnam are from Reuters (2010Q1 = 100). All variables are in logarithm.

Due to our measurement of trade balance as the ratio of export over import that leads to a potential problem is when import equals to zero of some commodities (coded by live animal (coded 00), dairy product and birds' eggs (02), feeding stuff for animal (08), tobacco (12), hides, skins and fur skins (21), oil seeds and oleaginous (22), pulp and waste paper (25), metalliferous ores (28), coal, coke and briquettes (32), gas, natural and manufactured (34), animal oils and fats (41), fixed vegetable fats and oil (42), vegetable fats and oil process/waste (43), inorganic chemical (52), dyeing, tanning and coloring material (53), medical and pharmaceutical products (54), fertilizers (56), plastic in primary form (57), nonferrous metal (68), coin including gold (95), gold and nonmonetary (97), estimate of low valued import transaction (98) and low value shipment (99)). In addition, these industries have very small weight trade. Therefore, we exclude these industries.

Table 1 also show the average trade weight during recent five years 2013-2018: The ten main commodities US exports to Vietnam are article of apparel and clothing, telecommunication equipment, footwear, furniture & bedding, electrical machinery and equipment, fish, miscellaneous manufactured articles, vegetables and fruit, travel goods and handbag. The ten main commodities US imports from Vietnam are electrical machinery and equipment, textile fibers, transport equipment, oil seeds and oleaginous, vegetables and fruit, feeding stuff animals, telecommunication equipment, nonferrous metal, plastics in primary form, and cork and wood (see Table 1).

Table 1: Trade share, import and export share over the period 2013-2018

(Insert Table 1 here)

3.2 Methods

We follow a standard model for bilateral trade of Rose and Yellen (1989), Bahmani-Oskooee and Muhammad (2018), Bahmani-Oskooee *et al.* (2018), the bilateral trade balance depends on real exchange rate, incomes of foreign country and domestic country. Hence, the bilateral trade balance between US and Vietnam are assumed in the long-run regression as follow:

$$TB_t = \alpha_0 + \alpha_1 GDP_t^{US} + \alpha_2 GDP_t^{VN} + \alpha_3 RER_t + \epsilon_t \quad (1)$$

As the trade balances data are reported from the US, we define *TB* as the ratio of the US's export to Vietnam over the US's import from Vietnam (in current price). The unit of the trade balance is free. GDP^{US}, GDP^{VN} are the US income and Vietnam income, proxied by the US's Gross Domestic Products (GDP) and Vietnam one; RER is real exchange rate (an increase in RER means appreciation of USD (or depreciation of VND))[6]; $t = 1; 2 \ldots T$ is number of periods.

In order to capture the short-run effect, we transpose equation (1) into an Autoregressive Distributed Lag (ARDL) equation developed by Pesaran *et al.* (2001) as follows.

[6]Notes that $RER = NER * P_{us}/P_{vn}$ where NER is the nominal exchange rate (USD/VND), an increase in NER indicates depreciation of VND; $P_{us}; P_{vn}$ are the consumer price index of US and Vietnam respectively.

$$\Delta TB_t = c + \rho_j TB_{t-1} + \rho_c GDP_{t-1}^{US} + \rho_d GDP_{t-1}^{VN} + \rho_e RER_{t-1} + \sum_{j=1}^{p} \varphi_i \Delta TB_{t-i} + \sum_{j=1}^{q} (\pi_{1i} \Delta GDP_{t-i}^{US} + \pi_{2i} \Delta GDP_{t-i}^{VN} + \pi_{3i} \Delta RER_{t-i}) + \upsilon_t \quad (2)$$

In order to determine asymmetric linkages between the exchange rate and trade balance, we need to compose a decomposition of exchange rate variables, by employing the approach of Schorderet(2003), Shin *et al*. (2014). The partial sums of positive and negative changes of the exchange rate indicating depreciation of VND (superscripts +) and appreciation of VND (superscripts -) are defined respectively:

$$RER_t^+ = \sum_{j=1}^{t} \Delta RER_j^+ = \sum_{j=1}^{t} max(\Delta RER_j, 0) \; ; \; ER_t^- = \sum_{j=1}^{t} \Delta RER_j^- = \sum_{j=1}^{t} min(\Delta RER_j, 0) \quad (3)$$

Therefore, equation (2) is transposed into the form in equation (4) which allows us to estimate the asymmetric long-run and short-run relationship.

$$\Delta TB_t = c + \rho_j TB_{t-1} + \rho_c GDP_{t-1}^{US} + \rho_d GDP_{t-1}^{VN} + \rho_e^+ RER_{t-1}^+ + \rho_e^- RER_{t-1}^- + \sum_{j=1}^{p} \varphi_i \Delta TB_{t-i} + \sum_{j=1}^{q} (\pi_{1i} \Delta GDP_{t-i}^{US} + \pi_{2i} \Delta GDP_{t-i}^{VN} + \pi_{3i}^+ \Delta RER_{t-i}^+ + \pi_{3i}^- \Delta RER_{t-i}^-) + \upsilon_t \quad (4)$$

The positive and negative long-run coefficients of the exchange rate are defined $L_e^+ = -\rho_e^+ / \rho_j$ and $L_e^- = -\rho_e^- / \rho_j$ whereas $L_{us} = -\rho_c / \rho_j$; $L_{vn} = -\rho_d / \rho_j$ are the long-run coefficients of US's GDP and Vietnam's GDP. In case of ARDL, long-run coefficient of exchange is computed by $L_e = \rho_e / \rho_j$. As our measurement of trade balance (export/import), an increase in domestic demand (i.e US's GDP) encourages more import, then ratio X/M decrease, indicating we expect the US's GDP coefficient be negative. Whereas an increase in foreign demand (i.e. Vietnam's GDP) leads the US export to be more to Vietnam, hence ratio X/M increases, suggesting a positive sign of Vietnam's GDP. In general, a decrease in in exchange rate (depreciation of USD) will support the US's export, then ratio X/M will increase. Hence, we expect a negative sign of exchange rate in case of ARDL model, but in NARDL, we expect a positive change of exchange rate (appreciation of USD) be negative, and its negative change (depreciation of USD) be positive.

Then, we verify the existence of cointegration among variables by using two test: First, t-statistic of Banerjee et al. (1998) that tests the null hypothesis of $\rho_j = 0$ against the alternative hypothesis $\rho_j < 0$. Second, F-test of Pesaran *et al.* (2001) that tests the null hypothesis of $\rho_j = \rho_c = \rho_d = \rho_e = 0$ (in case of ARDL model) by using lower bound and upper bound critical values. The lower bound critical value is computed in hypothesis all variables integrated of zero order, whereas the upper critical value is calculated in hypothesis all variables integrated of one order. In case of NARDL, Shinet al. (2014) also demonstrate the bounds test of Pesaran *et al.* (2001) could apply to test the cointegration, that is also a joint test on all the lagged levels regressors. The F -statistic tests the null hypothesis of $\rho_j = \rho_c = \rho_d = \rho_e^+ = \rho_e^- = 0$. If F-statistic is higher than the upper bound critical value, indicating the existence of cointegration.

The long-run symmetry can be tested by the Wald test of the null hypothesis of $L_e^+ = L_e^-$; to test the existence of short-run symmetry, we use the Wald test to test the null $\sum_{j=1}^{q} \pi_{3i}^+ = \sum_{j=1}^{q} \pi_{3i}^-$. If we reject the null hypothesis of symmetry, implying the model allow the asymmetric effect (both long-run and short-run).

4 Results

We estimate both symmetry and asymmetry models in Equations (2) and (4) respectively. We use the general-to-specific technical to find the optimal lag of each variable in order to find the best estimation. For each model, aggregated and disaggregated levels are estimated. We then verify the existence of cointegration by using t-test of Banerjee et al. (1998) and F-test Pesaran *et al.* 2001. We next establish the symmetry test of exchange rate by using Wald tests.

We first show the ARDL results. The estimated short-run coefficients are shown in Table 2, while the long-run ones in Table 3. Table 2 shows that the exchange rate does not impact on trade balance in aggregated level. However, the exchange rate coefficients of 16 commodities are significant at least 10% level. These commodities include meat and meat preparation (coded 03), vegetables and fruit (05), crude rubber (23), cork and wood (24), petroleum (33), plastics in no-primary form (58), leather and leather MFR (61), cork and wood manufactures (63), paper and paperboard (64), textile yarn fabric (65), metalworking machinery (73), transport equipment (79), prefabricated building sanitary and plumbing (81), articles of apparel and clothing (84), footwear (85), professional scientific instruments (87), photo apparel, equipment, optical goods (88), and all of them is weighed by 44.39%. In addition, among these commodities, the trade balance of 05, 24, 58, 73, 84 (articles of apparel and clothing, as the highest trade weight), 87 and 88 will improve when USD depreciate, whereas the trade balance of the rest of commodities will make worsen.

Table 2: Short-run estimations of ARDL
(Insert Table 2 here)

From the long-run estimations in Table 3, the exchange rate is significant at the 10% level to explain the bilateral trade balance in aggregated level. Compared to the significant commodities in the short-run, exchange rate is not significant in the long-run for six among 16 commodities, coded by 33, 64, 65, 73, 81 and 84. However, there are 6 other commodities that are significant only in long-run, coded by 09, 29, 55, 66, 75 and 93. In addition, recall that J-curve is when the significance of exchange rate on trade balance in long-run, not in the short-run (Bahmani-Oskooee, 1985). It suggests that the J-curve is established for aggregated level, and for these commodities in the ARDL model.

In addition, almost significant commodities will benefice when USD depreciates except some commodities coded 55, 63, 75, 79, 85 and 87. In these commodities, the footwear makes an attention when its weight is the third of largest trade weight between US and Vietnam. Vietnam is one of famous place of processing this commodity in the world. Vietnam imports the raw materials of footwear, and process to export to the word. Our finding suggests that a

depreciation of USD (i.e. appreciation of VND) worsens trade balance of US and Vietnam. Although raw material is more expensive, the firm in Vietnam must import it to product to maintain the processing. Hence, import will increase, resulting that trade balance will be worsened.

An increase in foreign income (i.e Vietnam's GDP increases), the US's trade balance with Vietnam of two commodities, namely textile yarn and fabrics (coded 65) and power generating machinery (71) will improve in the short-run, and improving for four commodities of coffee, tea, cocoa (07), petroleum (33), metalworking machinery (73) and office machinery and ADP equipment (75) in the long-run. However, an increase in domestic demand (i.e an increase of US's GDP), the trade balance of miscellaneous edible (09), crude fertilizers (27), essential oils (55), power generating machinery (71), machinery specialized (72), office machinery and ADP equipment (75), motor vehicles (78), transport equipment (79) will improve in short-run, and the long-run trade balance will improve for coffee, tea, cocoa (07), miscellaneous edible (09), crude animal and vegetable materials (29), leather (61), cork and wood manufactures (63), metalworking machinery (73), general industrial machinery (74), office machinery and ADP equipment (75), prefabricated building, sanitary, plumbing (81), professional scientific instrument (87), photo apparel, equipment, optical goods (88) and miscellaneous manufactured articles (89).

Table 3: Long-run estimations of ARDL
(Insert Table 3 here)

Allowing the exchange rate changes by two directions, appreciation and depreciation, we expect the impact of exchange rate on trade balance in NARDL will be more sensitive than in ARDL model in disaggregated level. We perform the NARDL estimation in Table 4 for the short-run estimations and in Table 5 for the long-run estimations. Remind that we expect positive changes of exchange rate coefficients (appreciation of USD) be negative, and negative change of exchange rate coefficients (depreciation of USD) be positive. Table 4 shows that the exchange rate decompositions in short-run are sensitive, and significant for 29 commodities (codes 01, 03, 04, 05, 06, 07, 11, 23, 24, 26, 29, 33, 59, 61, 62, 63, 64, 66, 67, 71, 73, 75, 77, 78, 79, 84, 85, 87, 88 and 89). These commodities weight 69.02%. Among these commodities, an appreciation of USD will improve the trade balance for commodities coded by 06, 24, 26, 59, 66, 75, 84, 85 and 88, whereas a depreciation of USD will improve the trade balance of commodities 03, 05, 07, 26, 29, 66, 67, 84, 85 and 89.

Table 4: Short-run estimations of NARDL
(Insert Table 4 here)

Table 4 presents the long-run coefficients, a depreciation of USD will improve the trade balance significantly of 10 commodities (codes 06 for sugars, sugar preparations, 23 for crude rubbers, 26 for textile fibers, 55 for essential oils, 65 for textile yarn, fabrics, 67 for iron and steel, 75 for office machine and ADP equipment, 79 for transport equipment, 85 for footwear and 87 for professional scientific instrument. However, an appreciation of USD will improve the trade

balance for 11 commodities coded by meat and meat preparations (01), vegetables and fruit (05), crude rubber (23), crude animal and vegetable materials (29), essential oils (55), rubber manufactures (62), iron and steel (67), power generating machinery (71), machinery specialized (72), metalworking machinery (73) and photo apparel, equipment, optical goods (88). In more detailed, among these commodities, only three commodities, 23, 55 and 67, in which exchange rate is very sensitive and significant with both directions, appreciation and depreciation. However, both directions of exchange rate have an inverted effect and significant as expected only for telecommunication equipment (code 76). This commodity is the one of the biggest weight trade (10.77%). This finding points out that an appreciation of USD (i.e. depreciation VND) will worsen the US's trade balance with Vietnam. This is because telecommunication equipment is an input of production of US's company in Vietnam like Intel Vietnam, which is imported then re-exported to the US. Hence, an appreciation in USD will not decrease the import as in the theory, but will increase the import for the production. This finding is consistent with Tran and Dinh (2014) who find that capital and intermediated goods will have inverted impact to the trade balance with the same argument.

Some commodities have an inverted effect and significant only either in depreciation or in appreciation: a depreciation of USD deteriorates the trade balance of fish (03), vegetables and fruit (05), miscellaneous edible (09), crude animal and vegetable material (29), leather (61), rubber manufactures (62), nonmetallic mineral (66), and photo apparel, equipment, optical goods (88). However, an appreciation of USD also worsens the trade balance of sugars, sugar preparations (06), coffee, tea, cacao (07), textile fibers (26), petroleum (33), cork and wood manufactures (63), paper and paperboard (64), transport equipment (79), prefab building, sanitary (81), and footwear (85). These commodities reflect by diversifying two types of goods, one is consumer goods and the other is raw material. The argument to explain for raw material is the same the telecommunication equipment. For the consumer goods such as fish, vegetables, sugar or coffee and tea, the price is not sensitive, suggesting that the US market still imports these products to consume.

Table 5: Long-run estimations of NARDL
(Insert Table 5 here)

When long and short-run estimations are performed, the diagnostic tests are presented in Table 6. We use *F*- upper bound critical value in Narayan (2005), and *t*-upper bound critical value in Pesaran *et al.* (2001) to compare t_{BDM} and F_{PSS} to conclude the cointegration. In aggregated level, both models of ARDL and NARDL confirm the existence of cointegration among trade balance, exchange rate and incomes of both countries when t_{BDM} and F_{PSS} statistics exceed their upper bounds. In disaggregated level, almost all industries confirm the existence of cointegration (both t_{BDM} and F_{PSS}) in both ARDL and NARDL models. The Wald test cannot reject the null hypothesis of cointegration for four commodities (codes 01, 11, 58 and 74), indicating the cointegration does not exist for both models of ARDL and NARDL for these commodities. Moreover, the long-run symmetry tests are rejected for commodities 07, 09, 23, 26, 33, 55, 63,

64, 67, 71, 72, 73, 75, 76, 79, 81 and 85, indicating that exchange rate is sensitive to trade balance at least for one direction (appreciation or depreciation).

Table 6: Diagnostic tests: cointegration ests and symmetry tests and R^2

(Insert Table 6 here)

5 Conclusion

In this paper, we investigate the effect of exchange rate on bilateral trade balance between Vietnam and the US over the period 2000Q4-2018Q4 by using ARDL and NARLD models. Our results show that the effect of (a)symmetry of exchange rate are not sensitive on the aggregated trade balance of Vietnam-US. However, the effects of exchange rate on disaggregated trade balance are different based on commodity category, and these effects are asymmetric in both long and short-runs. Moreover, the impact of the exchange rate on the trade balance in NARDL is more sensitive than in ARDL model in disaggregated level. More precisely, in the long-run, a depreciation of USD will improve the trade balance significantly of 10 commodities weighted 10.69% of trade share that are sugars and sugar preparations (code 06), crude rubbers (23), textile fibers (26), essential oils (55), textile yarn, fabrics (65), iron and steel (67), office machine and ADP equipment (75), transport equipment (79), footwear (85) and professional scientific instrument (87). However, an appreciation of USD will improve the trade balance for 11 commodities weighted 7.08% trade share that coded by meat and meat preparations (01), vegetables and fruit (05), crude rubber (23), crude animal and vegetable materials (29), essential oils (55), rubber manufactures (62), iron and steel (67), power generating machinery (71), machinery specialized (72), metalworking machinery (73) and photo apparel, equipment, optical goods (88). In the short-run, an appreciation of USD will improve the trade balance of commodities that are sugars, sugar preparations (06), cork and wood (24), textile fibers (26), chemical materials (59), nonmetallic mineral (66), office machines and equipment (75), article of apparels and clothing (84), footwear (85) and photo apparels, equipment and optical good (88). Whereas a depreciation of USD will improve the trade balance of commodities fish except marine mammal (03), vegetables and fruit (05), coffee, tea, cocoa (07), textile fibers (26), crude animal and vegetable materials (29), nonmetallic mineral (66), iron and steel (67), article of apparel and clothing (84), footwear (85) and miscellaneous manufactured articles (89). These commodities weight 69.02%. These results suggest that the industries will benefit from USD appreciation or depreciation.

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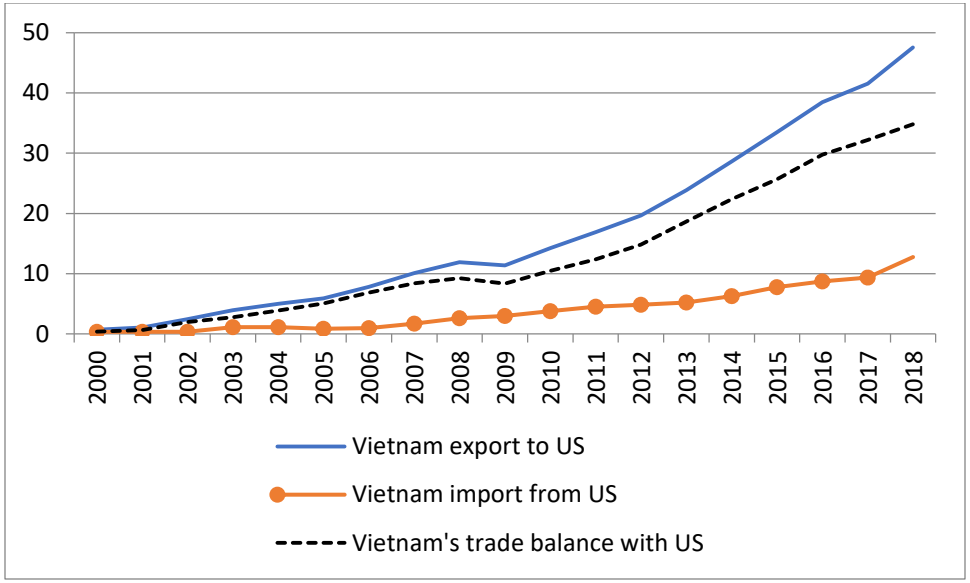

Figure 1: Export, Import and trade balance of Vietnam with the US. Vertical axis unit: billion USD

Table 1: Trade share, import and export share over the period of 2013-2018

Commodity [SITC code]	Trade share (%)	Import share (%)	Export share (%)	Commodity [SITC code]	Trade share (%)	Import share (%)	Export share (%)
Articles Of Apparel And Clothing [84]	22.63	0.08	27.16	Chemical Materials [59]	0.29	1.60	0.02
Telecommunications Equipment [76]	10.77	3.46	12.23	Dairy Products And Birds' Eggs [02]	0.28	1.68	0.00
Footwear [85]	10.30	1.79	12.01	Leather, Leather Mfr [61]	0.27	1.42	0.04
Electrical Machry, Apparatus, Appliances [77]	9.28	14.93	8.14	Beverages [11]	0.24	1.29	0.03
Furniture & Bedding [82]	8.46	0.07	10.14	Sugars, Sugar Preparations [06]	0.24	0.27	0.23
Office Machines And Adp Equipment [75]	4.63	1.23	5.31	Medicinal And Pharmaceutical Products [64]	0.23	1.35	0.00
Fish (Except Marine Mammal) [03]	3.23	1.39	3.60	Pulp And Waste Paper [25]	0.21	1.25	0.00
Miscellaneous Manufactured Articles [89]	3.08	1.15	3.47	Miscellaneous Edible [09]	0.20	0.81	0.07
Vegetables And Fruit [05]	2.98	5.15	2.55	Inorganic Chemicals [52]	0.17	0.81	0.05
Travel Goods, Handbags [83]	2.09	0.02	2.50	Special Transactions [93]	0.17	0.08	0.19
Textile Fibers [26]	1.83	10.65	0.06	Essential Oils [55]	0.16	0.66	0.06
Coffee, Tea, Cocoa [07]	1.53	0.27	1.78	Organic Chemicals [51]	0.16	0.65	0.06
Transport Equipment [79]	1.20	5.85	0.26	Photo Appt, Equipment & Optical Goods [88]	0.15	0.35	0.11
Manufactures Of Metals [69]	1.12	0.80	1.19	Estimate Of Low Valued Import Transactions [98]	0.15	0.14	0.16
Oil Seeds And Oleaginous [22]	0.98	5.83	0.00	Crude Rubber [23]	0.13	0.18	0.12
Machinery Specialized [72]	0.94	1.49	0.82	Plastics In Nonprimary Form [58]	0.13	0.43	0.07
General Industrial Machry [74]	0.92	2.43	0.62	Crude Animal And Vegetable Materials [29]	0.10	0.50	0.03
Textile Yarn, Fabrics [65]	0.92	0.87	0.93	Dyeing, Tanning And Coloring Materials [53]	0.08	0.31	0.03
Iron And Steel [67]	0.86	0.27	0.98	Metalworking Machinery [73]	0.08	0.43	0.01
Motor Vehicles [78]	0.86	2.25	0.58	Low Value Shipments [99]	0.07	0.25	0.04
Nonferrous Metals [68]	0.83	3.29	0.34	Prefab Buildings; Sanitary, Plumbing, Etc. [81]	0.06	0.06	0.07

Rubber Manufactures [62]	0.73	0.09	0.86	Crude Fertilizers [27]	0.05	0.13	0.04
Professional Scientific Instruments [87]	0.72	2.15	0.43	Gold, Nonmonetary [97]	0.05	0.01	0.06
Feeding Stuff For Animals [08]	0.68	3.86	0.05	Hides, Skins And Furskins [21]	0.04	0.26	0.00
Nonmetallic Mineral [66]	0.65	0.98	0.59	Tobacco And Tobacco [12]	0.03	0.18	0.01
Power Generating Machinery [71]	0.65	1.31	0.52	Fixed Veg. Fats & Oils [42]	0.03	0.06	0.03
Plastics In Primary Form [57]	0.55	3.13	0.03	Live Animals [00]	0.02	0.10	0.01
Cork And Wood [24]	0.52	3.02	0.02	Fertilizers [56]	0.01	0.08	0.00
Petroleum, Petroleum Products [33]	0.48	0.41	0.49	Anml/Veg Fats/Oils Process/Waste [43]	0.01	0.01	0.01
Cereals And Cereal Preparation [04]	0.47	2.18	0.13	Coin Including Gold [95]	0.00	0.01	0.00
Metalliferous Ores [28]	0.36	2.11	0.01	Animal Oils And Fats [41]	0.00	0.01	0.00
Cork And Wood Manufactures [63]	0.30	0.11	0.34	Coal, Coke And Briquettes [32]	0.00	0.00	0.00
Meat And Meat Preparations [01]	0.30	1.76	0.00	Gas, Natural And Manufactured [34]	0.00	0.00	0.00
Paper, Paperboard [64]	0.29	0.26	0.30				

Notes: SITC code is in [].

Table 2: Short-run estimations of ARDL model (estimated real exchange rate coefficients)

Commodity [SITC Code] (trade share)	RER_t	RER_{t-1}	RER_{t-2}	RER_{t-3}	RER_{t-4}
Meat and meat preparations [01] (0.3)					
Fish (except marine mammal) [03] (3.23)				7.57*** (2.65)	
Cereals and cereal preparation [04] (0.47)					
Vegetables and fruit [05] (2.98)	-7.4*** (2.69)	5.52** (2.72)			
Sugars, sugar preparations [06] (0.24)					
Coffee, Tea, Cocoa [07] (1.53)					
Miscellaneous edible [09] (0.2)					
Beverages [11] (0.24)					
Crude rubber [23] (0.13)					10.06*** (3.14)
Cork and Wood [24] (0.52)	-6.27** (2.9)				
Textile fibers [26] (1.83)					
Crude fertilizers [27] (0.05)					
Crude animal and vegetable materials [29] (0.1)					
Petroleum, Petroleum products [33] (0.48)					20.46** (8.92)
Organic chemicals [51] (0.16)					
Essential oils [55] (0.16)					
Plastics in nonprimary form [58] (0.13)	-6.91* (3.77)				
Chemical materials [59] (0.29)					
Leather, leather MFR [61] (0.27)	-7.50*** (2.77)			9.11*** (2.73)	
Rubber manufactures [62] (0.73)					
Cork and Wood manufactures [63] (0.3)	4.61** (1.81)				
Paper, Paperboard [64] (0.29)					
Textile yarn, fabrics [65] (0.92)			2.94* (1.49)		
Nonmetallic mineral [66] (0.65)					
Iron and Steel [67] (0.86)					
Manufactures of metals [69] (1.12)					

Power generating machinery [71] (0.65)					
Machinery specialized [72] (0.94)					
Metalworking machinery [73] (0.08)				-11.03** (4.28)	
General Industrial machry [74] (0.92)					
Office machine and ADP equipment [75] (4.63)					
Telecommunications equipment [76] (10.77)					
Electrical machry, Apparatus, Appliances [77] (9.28)	4.32 (3.05)	-5.15 (3.09)			
Motor vehicles [78] (0.86)					
Transport equipment [79] (1.2)			26.02** (11.67)		
Prefab Building; Sanitary; Plumbing; ect. [81] (0.06)					14.92*** (4.99)
Furniture & Bedding [82] (8.46)					
Travel goods, handbags [83] (2.09)					
Articles of Apparel and clothing [84] (22.63)					-10.29*** (3.71)
Footwear [85] (10.3)	2.55** (1.14)				2.91** (1.15)
Professional scientific instruments [87] (0.72)				-4.13** (1.88)	
Photo APPT, equipment, Optical goods [88] (0.15)					-9.81** (3.91)
Miscellaneous Manufactured articles [89] (3.08)					
Special transactions [93] (0.17)					
Aggregated level (100)					

Notes: SITC code is in [], trade weight is in parenthesis in the first column. *, **, *** mean the significant at the 1%, 5% and 10% respectively. Standard error is in parenthesis from the second column.

Table 2 (continued): Short-run estimations of ARDL model (estimated incomes coefficients)

Commodity [SITC Code] (trade share)	GDP_t^{US}	GDP_{t-1}^{US}	GDP_{t-2}^{US}	GDP_{t-3}^{US}	GDP_{t-4}^{US}	GDP_t^{VN}	GDP_{t-1}^{VN}	GDP_{t-2}^{VN}	GDP_{t-3}^{VN}	GDP_{t-4}^{VN}
Meat and meat preparations [01] (0.3)										
Fish (except marine mammal) [03] (3.23)										
Cereals and cereal preparation [04] (0.47)										
Vegetables and fruit [05] (2.98)										
Sugars, sugar preparations [06] (0.24)										
Coffee, Tea, Cocoa [07] (1.53)							-3.10* (1.77)			
Miscellaneous edible [09] (0.2)	-42.07** (17.67)									
Beverages [11] (0.24)										
Crude rubber [23] (0.13)										
Cork and Wood [24] (0.52)										
Textile fibers [26] (1.83)			40.26*** (14.47)							
Crude fertilizers [27] (0.05)				-57.27* (31.81)						
Crude animal and vegetable materials [29] (0.1)										
Petroleum, Petroleum products [33] (0.48)										
Organic chemicals [51] (0.16)				45.90** (20.06)						
Essential oils [55] (0.16)				-23.56** (11.07)						
Plastics in nonprimary form [58] (0.13)										
Chemical materials [59] (0.29)										
Leather, leather MFR [61] (0.27)		25.89** (9.81)								
Rubber manufactures [62] (0.73)										
Cork and Wood manufactures [63] (0.3)										
Paper, Paperboard [64] (0.29)										
Textile yarn, fabrics [65] (0.92)									0.98* (0.49)	
Nonmetallic mineral [66] (0.65)	23.63** (10.51)				36.91*** (10.03)					
Iron and Steel [67] (0.86)										

Manufactures of metals [69] (1.12)							
Power generating machinery [71] (0.65)		-45.07*** (13.36)			3.25** (1.45)		
Machinery specialized [72] (0.94)	-24.72** (10.22)						
Metalworking machinery [73] (0.08)					-8.19*** (2.32)	-4.67** (1.91)	
General Industrial machry [74] (0.92)							
Office machine and ADP equipment [75] (4.63)	-17.24*** (5.92)						
Telecommunications equipment [76] (10.77)							
Electrical machry, Apparatus, Appliances [77] (9.28)							
Motor vehicles [78] (0.86)		-39.39*** (14.25)					-2.60* (1.35)
Transport equipment [79] (1.2)			-94.26** (40.7)				
Prefab Building; Sanitary; Plumbing; ect. [81] (0.06)							
Furniture & Bedding [82] (8.46)							
Travel goods, handbags [83] (2.09)							
Articles of Apparel and clothing [84] (22.63)							
Footwear [85] (10.3)							
Professional scientific instruments [87] (0.72)	16.95*** (6.21)						
Photo APPT, equipment, Optical goods [88] (0.15)		34.88** (13.96)					
Miscellaneous Manufactured articles [89] (3.08)							
Special transactions [93] (0.17)							
Aggregated level (100)							

Notes: SITC code is in [], trade weight is in parenthesis in the first column. *, **, *** mean the significant at the 1%, 5% and 10% respectively. Standard error is in parenthesis from the second column.

Table 3: Long-run estimations of ARDL model

Commodity [SITC Code] (trade share)	RER	GDP^{US}	GDP^{VN}	constant
Meat and meat preparations [01] (0.3)	-13.37 (9.53)	33.17 (28.08)	-12.08 (7.98)	-2.48 (25.36)
Fish (except marine mammal) [03] (3.23)	-3.91*** (1.01)	5.88** (2.89)	-1.00 (0.79)	-2.66 (8.21)
Cereals and cereal preparation [04] (0.47)	0.33 (2.52)	6.62 (7.29)	-0.25 (1.98)	-23.35 (24.64)
Vegetables and fruit [05] (2.98)	-6.32*** (1.08)	-2.71 (3.11)	-0.41 (0.86)	25.34*** (9.3)
Sugars, sugar preparations [06] (0.24)	3.23 (2.08)	8.86 (5.96)	-1.20 (1.6)	-19.26* (11.18)
Coffee, Tea, Cocoa [07] (1.53)	0.83 (2.19)	-12.19* (6.18)	6.71*** (2.16)	4.72 (13.75)
Miscellaneous edible [09] (0.2)	-3.74* (1.88)	-14.10** (5.5)	2.01 (1.52)	29.99** (11.32)
Beverages [11] (0.24)	-6.90 (8.97)	-19.42 (21.97)	3.18 (5.93)	16.44 (22.38)
Crude rubber [23] (0.13)	-1.32* (0.73)	-3.19 (2.05)	0.42 (0.56)	18.83* (9.96)
Cork and Wood [24] (0.52)	-3.97** (1.77)	-3.28 (5.49)	1.13 (1.38)	10.93 (10.2)
Textile fibers [26] (1.83)	1.13 (3.71)	-3.77 (10.61)	0.01 (2.54)	4.06 (14.82)
Crude fertilizers [27] (0.05)	0.68 (2.39)	1.29 (7.21)	-3.08* (1.81)	10.40 (30.68)
Crude animal and vegetable materials [29] (0.1)	-1.90* (0.99)	-5.75* (2.89)	0.73 (0.77)	23.54** (10.29)
Petroleum, Petroleum products [33] (0.48)	-2.58 (2.94)	-4.08 (8.37)	5.23** (2.26)	-2.82 (28.01)
Organic chemicals [51] (0.16)	1.62 (2.57)	-2.73 (7.5)	-0.29 (1.88)	3.97 (18.65)
Essential oils [55] (0.16)	4.41** (1.85)	6.33 (5.48)	-0.95 (1.37)	-18.63* (10.64)
Plastics in nonprimary form [58] (0.13)	-6.21 (10.37)	-19.93 (25.46)	0.55 (6.5)	12.22 (11.72)
Chemical materials [59] (0.29)	2.05 (2.16)	-0.17 (6.14)	-0.34 (1.64)	-3.29 (17.72)
Leather, leather MFR [61] (0.27)	-7.40*** (0.87)	-6.06** (2.43)	0.40 (0.64)	47.99*** (10.39)
Rubber manufactures [62] (0.73)	-1.63 (2.68)	-8.88 (7.43)	-0.14 (2.05)	22.16 (17.85)
Cork and Wood manufactures [63] (0.3)	1.24* (0.74)	-5.52** (2.12)	-0.11 (0.58)	11.74* (5.94)
Paper, Paperboard [64] (0.29)	0.62 (3.96)	-10.35 (10.21)	1.72 (2.73)	7.62 (10.71)
Textile yarn, fabrics [65] (0.92)	2.24 (1.45)	9.83** (4.63)	-0.65 (1.15)	-13.15*** (4.66)
Nonmetallic mineral [66] (0.65)	-3.60*** (1.27)	-2.06 (3.68)	-0.03 (0.92)	15.17 (9.74)
Iron and Steel [67] (0.86)	6.59 (4.24)	-0.85 (12.2)	-1.91 (3.36)	-4.75 (16.4)
Manufactures of metals [69] (1.12)	-0.48 (2.36)	-9.23 (6.67)	0.94 (1.82)	13.63 (11.01)
Power generating machinery [71] (0.65)	0.36 (1.79)	12.98** (5.19)	-4.23** (1.76)	-22.36* (12.05)

Machinery specialized [72] (0.94)	4.14 (2.88)	-8.40 (7.57)	0.49 (2.13)	4.53 (9.77)
Metalworking machinery [73] (0.08)	3.95 (4.27)	-32.97*** (10.28)	11.54** (4.42)	26.74* (15.52)
General Industrial machry [74] (0.92)	-0.18 (2.59)	-15.65** (7.43)	1.42 (2.04)	17.00 (10.69)
Office machine and ADP equipment [75] (4.63)	2.41*** (0.83)	-11.70*** (2.51)	1.31** (0.64)	16.79*** (6.24)
Telecommunications equipment [76] (10.77)	2.87 (2.87)	-9.05 (8.63)	1.14 (2.26)	5.03 (9.94)
Electrical machry, Apparatus, Appliances [77] (9.28)	2.14 (3.07)	-12.66 (8.79)	2.30 (2.42)	8.17 (10.16)
Motor vehicles [78] (0.86)	3.28 (2.45)	-1.31 (6.73)	0.02 (1.79)	-3.83 (13.18)
Transport equipment [79] (1.2)	14.99*** (3.72)	-2.65 (10.49)	1.30 (2.73)	-51.11 (38.73)
Prefab Building; Sanitary; Plumbing; ect. [81] (0.06)	-2.31 (1.65)	-9.41** (4.7)	0.42 (1.27)	37.67** (16.51)
Furniture & Bedding [82] (8.46)	2.01 (2.56)	-10.61 (7.34)	1.40 (2.02)	11.42 (13.34)
Travel goods, handbags [83] (2.09)	4.76 (2.95)	-5.04 (8.67)	2.22 (2.3)	-12.51 (29.86)
Articles of Apparel and clothing [84] (22.63)	-0.43 (3.45)	3.34 (10.67)	-0.32 (2.67)	-3.91 (11.5)
Footwear [85] (10.3)	2.94*** (1.06)	-0.90 (3.01)	1.07 (0.81)	-4.70 (3.71)
Professional scientific instruments [87] (0.72)	4.73*** (0.63)	-5.43*** (1.91)	0.40 (0.49)	0.50 (5.46)
Photo APPT, equipment, Optical goods [88] (0.15)	-2.64* (1.47)	-12.25*** (4.18)	1.00 (1.1)	38.15*** (13.26)
Miscellaneous Manufactured articles [89] (3.08)	0.68 (0.56)	-3.80** (1.65)	0.32 (0.43)	6.68 (4.55)
Special transactions [93] (0.17)	3.36* (1.87)	-7.14 (5.37)	0.62 (1.48)	10.28 (19.5)
Aggregated level (100)	-1.27* (0.66)	-5.64*** (1.91)	0.64 (0.52)	17.26*** (6.16

Notes: SITC code is in [], trade weight is in parenthesis in the first column. *, **, *** mean the significant at the 1%, 5% and 10% respectively. Standard error is in parenthesis from the second column.

Table 4: Short-run estimations of NARDL model (estimated appreciation and depreciation of exchange rate coefficients)

Commodity [SITC Code] (trade share)	RER_t^-	RER_{t-1}^-	RER_{t-2}^-	RER_{t-3}^-	RER_{t-4}^-	RER_t^+	RER_{t-1}^+	RER_{t-2}^+	RER_{t-3}^+	RER_{t-4}^+
Meat and meat preparations [01] (0.3)									42.69**	
Fish (except marine mammal) [03] (3.23)				8.42** (3.63)						
Cereals and cereal preparation [04] (0.47)	-17.67* (10.35)									
Vegetables and fruit [05] (2.98)	-10.95*** (3.3)	9.15** (3.44)			7.88** (3.65)					
Sugars, sugar preparations [06] (0.24)	-8.46* (4.23)				-10.83** (4.51)		-19.34** (8.49)			
Coffee, Tea, Cocoa [07] (1.53)				-8.98 (5.66)	17.67*** (6.14)		-13.48 (11.13)			-16.39
Miscellaneous edible [09] (0.2)										
Beverages [11] (0.24)				-17.26** (6.96)				28.35** (12.33)	27.20**	
Crude rubber [23] (0.13)		-8.66** (4.0)								
Cork and Wood [24] (0.52)	-10.57*** (3.75)						-17.61** (8.11)			
Textile fibers [26] (1.83)	10.69** (5.26)							-20.45* (10.93)		
Crude fertilizers [27] (0.05)										
Crude animal and vegetable materials [29] (0.1)		8.21** (4.08)								
Petroleum, Petroleum products [33] (0.48)						52.25** (22.94)				36.31* (20.76)
Organic chemicals [51] (0.16)										

Essential oils [55] (0.16)										
Plastics in nonprimary form [58] (0.13)										
Chemical materials [59] (0.29)										
						-28.22*				
						(14.81)				
Leather, leather MFR [61] (0.27)										
	-8.45**	-9.05**					21.12***		11.73*	
	(3.48)	(3.89)					(7.37)		(6.03)	
Rubber manufactures [62] (0.73)	-14.71**									
	(6.5)									
Cork and Wood manufactures [63] (0.3)										
						14.53***				
						(4.51)				
Paper, Paperboard [64] (0.29)				-9.44**						
				(4.53)						
Textile yarn, fabrics [65] (0.92)										
Nonmetallic mineral [66] (0.65)										
									-	
	8.31**			13.17***	6.99*	-17.98**			23.64***	
	(3.58)			(3.94)	(3.66)	(7.61)			(6.92)	
Iron and Steel [67] (0.86)										
				13.26*						
				(6.85)						
Manufactures of metals [69] (1.12)										
Power generating machinery [71] (0.65)										
								20.81**		
								(9.64)		
Machinery specialized [72] (0.94)										
Metalworking machinery [73] (0.08)										
							24.31**			
							(10.94)			
General Industrial machry [74] (0.92)										
Office machine and ADP equipment [75] (4.63)										
	-3.78*						-7.72*			
	(1.89)						(4.15)			
Telecommunications equipment [76] (10.77)										
							-12.31	-15.56	-6.18	-1.21
							(8.95)	(9.47)	(8.56)	(8.01)
Electrical machry, Apparatus, Appliances [77] (9.28)	9.89**	-10.72**								
	(4.41)	(4.55)								

Motor vehicles [78] (0.86)										
	-10.95**						28.81***			
	(5.45)						(10.48)			
Transport equipment [79] (1.2)										
		-11.53*					53.84**			
		(6.46)					(30.08)			
Prefab Building; Sanitary; Plumbing; ect. [81] (0.06)										
Furniture & Bedding [82] (8.46)										
Travel goods, handbags [83] (2.09)										
								-8.49 (26.5)		
Articles of Apparel and clothing [84] (22.63)										
		20.34***						-39.41***		
		(4.74)						(9.25)		
Footwear [85] (10.3)										
	3.16**				6.03***					-5.77**
	(1.32)				(1.55)					(2.66)
Professional scientific instruments [87] (0.72)										
				-5.38**						
				(2.53)						
Photo APPT, equipment, Optical goods [88] (0.15)										
										-21.98**
										(9.11)
Miscellaneous Manufactured articles [89] (3.08)			5.01*							
			(2.88)							
Special transactions [93] (0.17)										
Aggregated level (100)										

Notes: SITC code is in [], trade weight is in parenthesis in the first column. *, **, *** mean the significant at the 1%, 5% and 10% respectively. Standard error is in parenthesis from the second column.

Table 4: Short-run estimations of NARDL model (estimated incomes coefficients)

Commodity [SITC Code] (trade share)	GDP_t^{US}	GDP_{t-1}^{US}	GDP_{t-2}^{US}	GDP_{t-3}^{US}	GDP_{t-4}^{US}	GDP_t^{VN}	GDP_{t-1}^{VN}	GDP_{t-2}^{VN}	GDP_{t-3}^{VN}	GDP_{t-4}^{VN}
Meat and meat preparations [01] (0.3)										
Fish (except marine mammal) [03] (3.23)										
Cereals and cereal preparation [04] (0.47)										
Vegetables and fruit [05] (2.98)										
Sugars, sugar preparations [06] (0.24)										
Coffee, Tea, Cocoa [07] (1.53)				-39.11**						
Miscellaneous edible [09] (0.2)										
Beverages [11] (0.24)										
Crude rubber [23] (0.13)		43.33*** (12.27)					-9.80*** (2.77)	-8.01*** (2.54)	-7.62*** (2.09)	-4.32*** (1.49)
Cork and Wood [24] (0.52)				-21.52*						
Textile fibers [26] (1.83)			32.59** (14.4)							
Crude fertilizers [27] (0.05)							-8.13** (3.95)			
Crude animal and vegetable materials [29] (0.1)										
Petroleum, Petroleum products [33] (0.48)										
Organic chemicals [51] (0.16)				45.85** (20.33)						
Essential oils [55] (0.16)							-6.74*** (2.04)	-3.11** (1.51)		
Plastics in nonprimary form [58] (0.13)										

Chemical materials [59] (0.29)								
Leather, leather MFR [61] (0.27)		31.49*** (9.45)		23.83** (9.91)		-5.28** (2.45)	-5.68** (2.21)	-4.75** (1.81)	-2.67** (1.21)
Rubber manufactures [62] (0.73)									
Cork and Wood manufactures [63] (0.3)				-15.94** (6.33)		4.31** (1.66)	3.82** (1.51)	2.50** (1.23)	1.60* (0.85)
Paper, Paperboard [64] (0.29)									
Textile yarn, fabrics [65] (0.92)								1.02** (0.51)	
Nonmetallic mineral [66] (0.65)			-22.71** (9.96)		40.17*** (9.14)				
Iron and Steel [67] (0.86)					38.68** (19.21)	-12.51** (4.94)	-10.77** (4.46)	-7.93** (3.62)	-5.40** (2.47)
Manufactures of metals [69] (1.12)									
Power generating machinery [71] (0.65)		-32.30** (13.89)							
Machinery specialized [72] (0.94)									
Metalworking machinery [73] (0.08)		40.18** (16.14)		29.35* (15.16)	41.43*** (15.27)	- 16.90*** (2.88)	-9.33*** (2.09)		
General Industrial machry [74] (0.92)									
Office machine and ADP equipment [75] (4.63)	- 21.85*** (6.06)					-5.86*** (1.5)	-5.61*** (1.32)	-4.25*** (1.07)	-2.13*** (0.72)
Telecommunications equipment [76] (10.77)					-23.36* (12.99)	11.81*** (3.91)	10.74** (7.84)	7.84*** (2.77)	4.07** (1.79)
Electrical machry, Apparatus, Appliances [77] (9.28)									
Motor vehicles [78] (0.86)		-32.81** (14.03)							
Transport equipment [79] (1.2)			- 102.07** (43.17)						
Prefab Building; Sanitary; Plumbing; ect. [81] (0.06)									

Furniture & Bedding [82] (8.46)			
Travel goods, handbags [83] (2.09)	-69.01* (40.88)		
Articles of Apparel and clothing [84] (22.63)	-27.05** (12.75)		
Footwear [85] (10.3)			
Professional scientific instruments [87] (0.72)	19.44*** (7.02)		
Photo APPT, equipment, Optical goods [88] (0.15)		32.91** (13.3)	
Miscellaneous Manufactured articles [89] (3.08)			
Special transactions [93] (0.17)			
Aggregated level (100)			-11.56* (6.12)

Notes: SITC code is in [], trade weight is in parenthesis in the first column. *, **, *** mean the significant at the 1%, 5% and 10% respectively. Standard error is in parenthesis from the second column.

Table 5: Longrun estimated NARDL

Commodity [SITC Code] (trade share)	RER^-	RER^+	GDP^{US}	GDP^{VN}	constant
Meat and meat preparations [01] (0.3)	-15.86* (8.16)	-64.02** (28.12)	65.60** (25.99)	-9.36 (7.12)	-59.94** (24.72)
Fish (except marine mammal) [03] (3.23)	-3.61*** (1.09)	0.53 (3.64)	4.04 (2.92)	-1.36 (0.82)	-8.12 (7.13)
Cereals and cereal preparation [04] (0.47)	-0.69 (2.37)	-7.09 (7.78)	6.19 (6.81)	0.88 (1.96)	-28.17 (21.36)
Vegetables and fruit [05] (2.98)	-7.36*** (1.22)	-10.02** (4.13)	-3.21 (3.04)	-0.17 (0.87)	8.44 (6.84)
Sugars, sugar preparations [06] (0.24)	5.02*** (1.77)	12.66** (6.31)	5.20 (4.65)	-0.95 (1.3)	-9.49 (9.39)
Coffee, Tea, Cocoa [07] (1.53)	0.49 (1.73)	15.72** (5.94)	-10.74** (4.48)	2.36* (1.22)	21.38 (12.9)
Miscellaneous edible [09] (0.2)	-2.90* (1.62)	7.07 (5.26)	-16.15*** (4.76)	0.62 (1.38)	34.84*** (10.47)
Beverages [11] (0.24)	-8.54 (8.22)	-59.75 (48.74)	13.81 (33.91)	6.53 (6.93)	-16.08 (17.67)
Crude rubber [23] (0.13)	3.25** (1.40)	-5.71** (2.49)	-12.35*** (3.07)	7.63*** (1.94)	11.47 (8.09)
Cork and Wood [24] (0.52)	-3.53 (2.23)	-5.75 (7.60)	1.80 (7.53)	1.26 (1.72)	-5.18 (9.77)
Textile fibers [26] (1.83)	5.12* (2.56)	20.71** (8.43)	-7.42 (7.34)	-1.09 (1.81)	18.49 (12.55)
Crude fertilizers [27] (0.05)	2.83 (3.04)	-4.74 (8.27)	-10.88 (8.54)	3.31 (3.61)	28.18 (25.53)
Crude animal and vegetable materials [29] (0.1)	-2.60** (1.06)	-6.13* (3.57)	-4.52 (2.99)	0.84 (0.84)	12.05 (8.66)
Petroleum, Petroleum products [33] (0.48)	1.89 (2.52)	22.56** (8.62)	-4.43 (7.29)	2.55 (2.04)	0.53 (23.92)
Organic chemicals [51] (0.16)	1.65 (2.78)	1.86 (8.84)	-2.77 (7.75)	-0.31 (2.07)	8.42 (15.9)
Essential oils [55] (0.16)	5.83*** (1.49)	-8.52** (3.27)	-5.87 (3.76)	6.56*** (1.96)	-8.84 (8.1)
Plastics in nonprimary form [58] (0.13)	-8.53 (12.70)	-6.74 (35.37)	-28.33 (31.01)	-1.14 (8.61)	13.10 (12.31)
Chemical materials [59] (0.29)	1.82 (2.11)	5.36 (6.96)	-2.96 (5.79)	-0.54 (1.65)	12.84 (15.21)
Leather, leather MFR [61] (0.27)	-3.12** (2.11)	-2.61 (2.78)	-13.19*** (3.5)	4.56** (2.13)	31.48*** (8.12)
Rubber manufactures [62] (0.73)	-3.94** (1.78)	-11.20* (5.75)	-9.71* (5.18)	0.54 (1.49)	27.26* (14.11)
Cork and Wood manufactures [63] (0.3)	-0.99 (1.34)	8.45*** (2.25)	3.12 (3.29)	-5.80*** (1.96)	13.97** (5.68)
Paper, Paperboard [64] (0.29)	5.06 (3.61)	24.71** (11.48)	-15.01 (9.17)	0.25 (2.61)	16.73 (10.2)
Textile yarn, fabrics [65] (0.92)	2.76* (1.64)	3.10 (5.39)	9.8* (5.29)	-0.37 (1.35)	-10.20** (4.2)
Nonmetallic mineral [66] (0.65)	-3.77*** (1.29)	0.47 (4.18)	-5.38 (3.27)	-0.39 (0.83)	16.66** (7.72)
Iron and Steel [67] (0.86)	15.51** (6.14)	-33.46*** (10.21)	-26.68* (14.77)	22.00** (8.96)	-4.44 (14.38)
Manufactures of metals [69] (1.12)	0.05 (2.06)	7.89 (6.71)	-13.11** (5.98)	0.10 (1.74)	24.81** (10.89)
Power generating machinery [71] (0.65)	1.29 (1.54)	-10.20* (5.41)	10.84** (4.56)	-0.32 (1.16)	-29.52*** (10.27)

Machinery specialized [72] (0.94)	0.41 (2.08)	-18.84*** (6.68)	-3.94 (5.94)	2.06 (1.75)	2.59 (8.12)
Metalworking machinery [73] (0.08)	-0.19 (2.04)	-24.49*** (5.33)	-36.55*** (6.0)	16.40*** (3.06)	52.99*** (12.69)
General Industrial machry [74] (0.92)	-0.69 (2.99)	-6.02 (11.18)	-14.30* (8.46)	2.08 (2.56)	13.03 (11.07)
Office machine and ADP equipment [75] (4.63)	7.25*** (1.31)	0.41 (2.3)	-23.07*** (2.7)	8.81*** (1.7)	33.64*** (7.16)
Telecommunications equipment [76] (10.77)	-7.75** (3.82)	28.59*** (6.35)	6.27 (9.44)	-18.96*** (5.41)	43.06*** (13.72)
Electrical machry, Apparatus, Appliances [77] (9.28)	2.37 (3.74)	19.46 (12.48)	-19.46* (10.65)	-0.28 (3.06)	20.18* (11.01)
Motor vehicles [78] (0.86)	1.83 (2.19)	-2.87 (7.13)	0.49 (5.84)	-0.21 (1.63)	-0.03 (10.68)
Transport equipment [79] (1.2)	19.50*** (3.86)	39.36*** (12.41)	-5.11 (10.45)	-0.37 (2.91)	22.32 (32.25)
Prefab Building; Sanitary; Plumbing; ect. [81] (0.06)	-0.009 (1.50)	15.02*** (4.93)	-15.87*** (4.32)	-0.51 (1.24)	60.61*** (15.37)
Furniture & Bedding [82] (8.46)	2.47 (2.57)	7.40 (8.31)	-11.93 (7.4)	0.81 (2.15)	19.92 (12.65)
Travel goods, handbags [83] (2.09)	4.99 (4.24)	7.14 (14.98)	-13.53 (12.11)	2.95 (3.36)	27.66 (31.20)
Articles of Apparel and clothing [84] (22.63)	1.94 (2.03)	10.77 (7.23)	-12.01** (5.62)	0.80 (1.55)	20.17** (9.91)
Footwear [85] (10.3)	2.69*** (0.91)	7.25** (2.99)	-4.81* (2.49)	0.80 (0.67)	4.86 (3.01)
Professional scientific instruments [87] (0.72)	4.68*** (0.71)	3.45 (2.56)	-4.65** (2.04)	0.48 (0.52)	12.63** (5.43)
Photo APPT, equipment, Optical goods [88] (0.15)	-3.94*** (1.34)	-8.80* (4.69)	-12.81*** (3.7)	1.48 (1.03)	34.57*** (11.11)
Miscellaneous Manufactured articles [89] (3.08)	-1.61 (2.06)	-6.08 (6.95)	-4.30 (5.83)	0.17 (1.63)	4.80 (6.39)
Special transactions [93] (0.17)	3.23 (1.94)	1.71 (6.3)	-6.73 (5.62)	0.80 (1.63)	21.17 (17.76)
Aggregated level (100)	-0.31 (0.59)	2.73 (1.89)	-4.95*** (1.57)	0.32 (0.44)	15.18*** (5.24)

Notes: SITC code is in [], trade weight is in parenthesis in the first column. *, **, *** mean the significant at the 1%, 5% and 10% respectively. Standard error is in parenthesis from the second column.

Table 6: Diagnostic test: Cointegration tests, long run symmetry test and R^2

Models	NARDL				ARDL		
Commodity [SITC Code] (trade share)	F_{PSS}	t_{BDM}	W_{LR}	R^2	F_{PSS}	t_{BDM}	R^2
Meat and meat preparations [01] (0.3)	2.99	-3.36	3.84*	0.13	2.81	-2.98	0.13
Fish (except marine mammal) [03] (3.23)	9.38***	-6.67***	1.81	0.54	11.70***	-6.74***	0.30
Cereals and cereal preparation [04] (0.47)	11.30***	-7.40***	0.88	0.47	12.76***	-7.05***	0.45
Vegetables and fruit [05] (2.98)	7.18***	-5.82***	0.59	0.82	8.02***	-5.53***	0.81
Sugars, sugar preparations [06] (0.24)	6.53***	-5.14***	2.09	0.53	4.30*	-4.08**	0.46
Coffee, Tea, Cocoa [07] (1.53)	8.15***	-6.25***	9.51***	0.47	8.19***	-5.61***	0.35
Miscellaneous edible [09] (0.2)	6.07***	-5.40***	4.63**	0.26	6.34***	-4.92***	0.23
Beverages [11] (0.24)	2.38	-1.51	1.11	0.46	1.06	-1.49	0.38
Crude rubber [23] (0.13)	16.17***	-8.81***	9.52***	0.73	14.96***	-7.58***	0.68
Cork and Wood [24] (0.52)	11.51***	-6.04***	0.11	0.47	8.55***	-5.54***	0.41
Textile fibers [26] (1.83)	5.10**	-4.75***	4.75**	0.32	4.12*	-3.75*	0.25
Crude fertilizers [27] (0.05)	12.96***	-7.79***	0.93	0.50	16.78***	-8.13***	0.50
Crude animal and vegetable materials [29] (0.1)	11.77***	-7.58***	1.31	0.61	14.35***	-7.54***	0.59
Petroleum, Petroleum products [33] (0.48)	10.97***	-7.24***	7.55***	0.44	11.92***	-6.87***	0.39
Organic chemicals [51] (0.16)	4.69**	-4.69***	0.001	0.25	5.97***	-4.74***	0.26
Essential oils [55] (0.16)	4.69**	-7.15***	18.04***	0.45	3.68	-3.66	0.42
Plastics in nonprimary form [58] (0.13)	0.65	-1.26	0.003	0.04	0.74	-1.34	0.08
Chemical materials [59] (0.29)	8.65***	-6.45***	0.35	0.44	9.35***	-6.05***	0.42

Leather, leather MFR [61] (0.27)	18.23***	-9.38***	0.02	0.63	15.05***	-7.71***	0.52
Rubber manufactures [62] (0.73)	7.62***	-6.13***	2.05	0.31	3.54	-3.61*	0.30
Cork and Wood manufactures [63] (0.3)	9.59***	-6.67***	11.76***	0.45	8.83***	-5.87***	0.33
Paper, Paperboard [64] (0.29)	7.20***	-3.86*	4.09**	0.65	8.36***	-3.77*	0.63
Textile yarn, fabrics [65] (0.92)	11.10***	-5.40***	0.005	0.50	15.58***	-5.88***	0.53
Nonmetallic mineral [66] (0.65)	11.98***	-7.32***	1.53	0.54	9.59***	-5.91***	0.42
Iron and Steel [67] (0.86)	6.77***	-5.38***	15.57***	0.27	3.47	-3.72*	0.12
Manufactures of metals [69] (1.12)	4.02*	-4.42**	1.769	0.17	4.13*	-3.96**	0.23
Power generating machinery [71] (0.65)	14.28***	-7.73***	6.16**	0.52	17.81***	-7.84***	0.50
Machinery specialized [72] (0.94)	3.78*	-4.13**	10.43***	0.16	3.56	-3.52*	0.13
Metalworking machinery [73] (0.08)	16.54***	-8.50***	20.49***	0.59	4.85***	-3.85**	0.51
General Industrial machry [74] (0.92)	1.66	-2.36	0.29	0.15	2.01	-2.72	0.16
Office machine and ADP equipment [75] (4.63)	10.26***	-6.91***	6.66**	0.44	21.13***	-8.99***	0.61
Telecommunications equipment [76] (10.77)	7.03***	-5.65***	23.89***	0.26	9.65***	-5.00***	0.43
Electrical machry, Apparatus, Appliances [77] (9.28)	2.10	-3.04	2.46	0.15	4.44*	-3.83**	0.19
Motor vehicles [78] (0.86)	8.22***	-6.11***	0.61	0.34	6.69***	-4.96***	0.28
Transport equipment [79] (1.2)	10.61***	-7.24***	3.59*	0.43	12.89***	-7.16***	0.43
Prefab Building; Sanitary; Plumbing; ect. [81] (0.06)	11.37***	-7.49***	12.12***	0.42	12.47***	-7.00***	0.41
Furniture & Bedding [82] (8.46)	4.05*	-4.45**	0.45	0.17	4.99***	-4.438591	0.18
Travel goods, handbags [83] (2.09)	7.89***	-6.16***	0.02	0.32	13.08***	-7.06***	0.44
Articles of Apparel and clothing [84] (22.63)	9.68***	-6.76***	2.07	0.57	7.12***	-3.50*	0.46
Footwear [85] (10.3)	6.01***	-5.06***	3.22*	0.46	5.06***	-4.25**	0.34

Professional scientific instruments [87] (0.72)	7.15***	-5.74***	0.31	0.48	9.06***	-5.81***	0.49
Photo APPT, equipment, Optical goods [88] (0.15)	12.83***	-7.83***	1.46	0.46	13.26***	-7.10***	0.42
Miscellaneous Manufactured articles [89] (3.08)	3.78*	-3.92*	0.56	0.15	22.83***	-9.01***	0.56
Special transactions [93] (0.17)	10.77***	-7.31***	0.07	0.40	13.63***	-7.38***	0.41
Aggregated level (100)	10.36***	-7.12***	3.63*	0.40	8.91***	-5.95***	0.30

Notes: SITC code is in [], trade weight is in parenthesis in the first column. *, **, *** mean the significant at the 1%, 5% and 10% respectively.