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Abstract

Exchange rate pass-through always deserves interest of policy makers and economists. In this paper, we study the measure of exchange rate pass-through on consumer price for Vietnam by using Nonlinear Autoregressive Dynamic Lag in the period from 2000Q4 to 2018Q2. Our findings can be summarized as follow: (i) we demonstrates the existence of asymmetric effect of exchange rate to domestic price in both short run and long run; (ii) the exchange rate pass-through is high; (iii) impact of exchange rate depreciation on domestic price is stronger than appreciation; (iv) the exchange rate pass-through is higher in the long-run than in the short run; (v) foreign competitor price plays an important role for domestic price movement.

Keywords: Exchange rate pass-through, Asymmetric exchange rate, ARDL models, NARDL models,
JEL: C22, E41, F31, F33, F41

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1. Introduction

Since the Bretton Woods agreements, economists have focused on the impact of exchange rates variation on consumer price indexes. The policy regime and central bank credibility are an important factor for the exchange rate pass-through (thereafter ERPT). In countries with a flexible exchange rate regime, the pass-through should be lower than in a fixed one. The convention has been for a long time that pass-through is relatively complete and fast in less developed and small countries. Therefore, understanding ERPT is a fundamental issue for central banks whose primary task is to ensure price stability.

The exchange rate pass-through measures the degree of nominal exchange rate effect to prices (import price or domestic price). When the appreciation (or depreciation) of the exchange rate are fully transmitted into domestic prices, the ERPT is said to be complete. In contrast, if the transmissions of exchange rate variations into domestic prices are less proportional, the ERPT is partial.

Several empirical studies find that ERPT in many countries is partial. Two possible reasons are at work: the behavior of exporting firms (exporters maintain their market share when there is an appreciation of country exporter currency) and nominal rigidities (price is unresponsive in short run) (see Betts and Devereux (2000); Monacelli (2005); López-Villavicencio and Mignon (2017)).

Over the past years, an extensive literature has been developed on exchange rate pass-through. For instance, McCarthy (2007) found that ERPT into consumer price index and producer price index in industrialized countries is small due to some reasons such as less volatile of exchange rate, stability of GDP growth and less competitiveness. Campa and Goldberg (2005) examined ERPT into import prices of 23 OECD countries over quarterly data from 1975 to 2003. They found that unweighted averages ERPT across countries is 0.46 in the short run, and 0.64 in the long run. In addition, higher degree of ERPT is concerning higher exchange rate volatility. However, ERPT in the emerging market is higher than ERPT in advanced countries (Web-

ber, 1999; Mihaljek and Klau, 2001; Ghosh, 2013). Webber (1999) studied the ERPT into import prices in eight Asian Pacific countries. He analyzed ERPT into prices for 13 emerging markets during the 1980s and 1990s. High ERPT is found for Brazil and Mexico, Turkey, Hungary and Poland. Ghosh (2013) studied ERPT in Latin America countries from 1970 to 2010, and he found that ERPT into CPI is higher for Mexico with 91%, Uruguay with 71%, Brazil with 53% and Chile with 46%.

In term of emerging market, Vietnam is a good example: stability macroeconomic, well controlled inflation and regulated monetary policy. As a result, Vietnam is amongst the countries growing the fastest in the world, at 6.5% annual rate over the period 2000-2018. Beside the high economic growth, the inflation is changing through different stages. It surges to the 2-digit inflation in the crisis period of 2008 and 2011, and it is around 6% for the whole period from 2000 to 2018. Faced on high inflation pressure, the government sets stability price targeting and macroeconomic stability as a priority target, the State Bank of Vietnam (SBV, central bank) used many monetary policy tools in order to control inflation. On the other side, exchange rate plays an important role in monetary policy. The SBV has geared the exchange rate regime toward more flexibility and in line with exchange foreign markets. USD/VND exchange rate follows a crawling peg exchange rate. The SBV sets the reference rate to oriented exchange foreign market, and the exchange rate will move in a band setting by central bank. Before 2015, the reference rate was the average of latest price trading. After 2015, reference rate is calculated based on basket of eight currencies in order oriented exchange rate for the market The band is small (+-1%, +-2%) in the exchange rate pressure period, and the band is +-3% in the recent period.

A few studies of ERPT in Vietnam have been produced, but the results are mixed. Vo (2009); Nguyen et al. (2009) pointed out low-end ERPT, whereas Pham (2016) found the high ERPT. The empirical literature has paid little attention to the issue of asymmetries in ERPT, despite the importance of this assumption for monetary authorities, and a similar study for Vietnam is

still missing. This paper aims at filling this gap. We focus on the scale of the exchange rate pass-through into domestic prices during the period 2000Q4-2018Q2 by using a novel approach, the Non-Linear Autoregressive Distributed Lags (thereafter NARDL) estimator, developed by Shin et al. (2014). This methodology allows us, in the one hand, to distinguish the transmissions of positive and negative changes of exchange rate into domestic prices, which is not the case with linear models[1]. In the other hand, it allows for analyzing the transmissions of exchange rate in both long and short-run.

The remainder of this paper is organized as follow: Section 2 summarizes the literature review of ERPT in Vietnam. Section 3 introduces methodology to estimate ERPT in Vietnam. Section 4 discusses the results. Section 5 concludes.

2. Literature Review

Only a few empirical studies have examined the exchange rate pass-through in Vietnam and the majority of those papers have used a vector autoregressive model (VAR). Nguyen and Fujita (2007) used monthly data from 1992M1 to 2005M4, and a set of variables including industrial output, domestic price, real bilateral exchange rate, money supply, trade deficit and US interest rate. They found that the exchange rate has a small impact on inflation.

Vo (2009) used monthly data over only 7 years from 2001M1 to 2007M2, and a set of variables including consumer price index, oil prices, nominal effective exchange rate (NEER), output gap, import price, and money supply. He also found that the ERPT is very small 0.08 and the impact of exchange rate to consumer price is removed after 15 months.

Bhattacharya (2014) tried to figure out what are the main drivers of inflation in Vietnam, from 2004Q1 to 2012Q2, by using growth rates of CPI, output, credit to the economy, nominal effective exchange rate, and the nominal interest rate. The results suggest that the NEER and the foreign inflation are the most important variables explaining the inflation.

[1] Generally speaking, there is no *ex ante* reasons in social sciences to think that the effect of a variable on another is symmetric. It seems more reasonable to assume that symmetry is a particular case of asymmetry.

Pham (2016) studied the same issue based on the period of 2002Q1-2016Q3, and applied a structural VAR model by including growth rate of output (GDP), consumer price (in headline level and its components (disaggregated level of CPI)), money supply, NEER and interest rate (only this variable in level). He concluded that the correlation between exchange rate pass-through and the average of inflation is above 0.87 after 4 quarters.

Some monetary policy variables such as credit to the economy, money supply or interest rate are less explanatory (less 5% or 10%) or have no clear relationship to inflation (IMF, 2003; Le and Pfau, 2009; Camen, 2006). Therefore, we will not include money supply, credit and the interest rate in our model.

The shortcoming of these studies can be summarized as follow: First, all models have used linear VAR model. These studies only analyze the reaction of a shock to domestic price through Impulse Response Function and do not interpret estimated coefficients. Second, based on linear models, the elasticity of exchange rate on inflation rate is the same for different variations of exchange rate (appreciation or depreciation). However, several theoretical arguments point out the ERPT to consumer price could be asymmetric due to market share, capacity constraints, other rigidities (quantity or export prices) (Marston, 1990; Knetter, 1994; Pollard and Coughlin, 2003). For example, market share theory depends on the strategy of the exporter firms. If firms target certain market shares, an appreciation of an exporting country's currency (depreciation of the home currency) will cause exporters to try maintaining their market share by reducing their markups (there is an offset of the price increase expressed in the exporter's currency).

The asymmetry in ERPT have been investigated in Delatte and López-Villavicencio (2012); Bussière (2013); Brun-Aguerre et al. (2017); El bejaoui (2013). Delatte and López-Villavicencio (2012) followed a mark-up model, and investigated an asymmetric non-linear ARDL to assess the ERPT to consumer price index for Japan, Germany, the United Kingdom and the United States. Bussière (2013) analyzed the relationship between trade prices (import and export prices) and exchange rate movements in the G7 economies by using non-linear and asymmetric ef-

fects. The author used foreign prices and the producer price index to explain the ERPT on import and export prices. El bejaoui (2013) also used an NARDL model and investigated the reaction of export and import prices to changes in exchange rate asymmetry for 4 advanced countries namely Germany, France, Japan, and the United States. Brun-Aguerre et al. (2017) investigated asymmetry ERPT into import prices of 33 emerging and developed countries from 1980Q1 to 2010Q4. They used an NARDL model for estimating ERPT of each country, and a Mean Group estimator for panel data. Their finding is that ERPT is higher for depreciations than appreciations over both short and long-run for Argentina, China, Greece, Israel and Thailand.

In order to contribute to fill these gaps, we apply a NARDL model to reassess ERPT in Vietnam. Our main contributions are (i) to create a foreign competitor price index capturing the impact of foreign price on domestic price; (ii) to show the different magnitudes of appreciation and depreciation of the exchange rate to consumer price; (iii) to perform the ERPT in both the short and long run; (iv) to generate dynamic multipliers showing new long-run equilibrium from an initial long-run equilibrium for the consumer price with the positive and negative shocks of the exchange rate.

3. Methodology

As we will discuss the potential variables explaining the ERPT in this section, we follow Delatte and López-Villavicencio (2012) to estimate ERPT to consumer price index as follow:

$$CPI_t = \alpha_0 + \alpha_1 NEER_t + \alpha_2 Oil_t + \alpha_3 FCP_t + \epsilon_t \tag{1}$$

Where: CPI are consumer price index; $NEER$ is the nominal effective exchange rate[2]; Oil is the Brent oil price; FCP is the foreign competitor price; ϵ_t is the error term.

[2]An increase in NEER means a depreciation of Vietnamese currency (VND)

We use the NEER instead of the bilateral nominal exchange rate because it takes into account (any) shifts throughout the sample period with Vietnam respective trading partners, unlike the nominal bilateral exchange rate. An increase (decrease) in the NEER implies a depreciation (an appreciation) of the home currency (VND). We expect a positive sign.

Foreign competitor price (FCP) is calculated as the weighted average of foreign price and is derived using the definition of the real effective exchange rate (see Brun-Aguerre et al. (2017); López-Villavicencio and Mignon (2017)). The specification of FCP is very important in our model. A better indicator to use should be the export price of Vietnam's trading partner weighted by the share of import from these countries (Mihaljek and Klau, 2001). However, these data are not available for the main trading partners of Vietnam, especially Asian countries. As a result, we use foreign competitor price. We expect a positive sign.

Oil is an input for the production, suggesting that an increase in oil price (or decrease in oil supply) will push up the cost of manufacturing, leading to a rise in domestic inflation. We hence use world oil price as a proxy for supply shocks to capture effects of external demand pressure on the real side of the economy. We expect a positive sign.

To capture the short-run effect in equation (1), we transpose this equation into an ARDL model as follow:

$$\begin{aligned}\Delta CPI_t = {} & c_1 + \rho_j CPI_{t-1} + \rho_c NEER_{t-1} + \rho_d Oil_{t-1} + \rho_e FCP_{t-1} \\ & + \sum_{i=1}^{p} \varphi_i \Delta CPI_{t-i} + \sum_{j=0}^{q} \left(\pi_{1j} \Delta NEER_{t-j} + \pi_{2j} \Delta Oil_{t-j} + \pi_{3j} \Delta FCP_{t-j} + \pi_{4j} Gap_{t-j}\right) + \nu_t \quad (2)\end{aligned}$$

Where Δ is the first difference of each variable. We include the output gap (*Gap*) in the short run (see de Brouwer and Ericsson (1998); Delatte and López-Villavicencio (2012)). The output gap is used to capture the domestic demand pressure and to take into account the business cycles. When the actual GDP is above the potential GDP it reflects a positive output gap, which means that the economy is growing over its long run capacity (or over the full employment

capacity), leading to an increase of inflation. Hence, we expect a positive sign.

Shin et al. (2014) introduced the decomposition of the exchange rate into its positive and negative partial sums, as follow:

$$NEER_t^+ = \sum_{j=1}^{t} \Delta NEER_j^+ = \sum_{j=1}^{t} max(\Delta NEER_j, 0)$$
$$NEER_t^- = \sum_{j=1}^{t} \Delta NEER_j^- = \sum_{j=1}^{t} min(\Delta NEER_j, 0) \quad (3)$$

Where $NEER_t^+$, $NEER_t^-$ are the partial sums of positive and negative changes of the (log) nominal effective exchange rate, indicating respectively depreciation (superscripts +) and appreciation of VND (superscripts -). Therefore, equation (2) changes from symmetry effect to asymmetry effect as follow:

$$\Delta CPI_t = c_1 + \rho_j CPI_{t-1} + \rho_c^+ NEER_{t-1} + \rho_c^- NEER_{t-1} + \rho_d Oil_{t-1} + \rho_e FCP_{t-1} + \sum_{i=1}^{p} \varphi_i \Delta CPI_{t-i}$$
$$+ \sum_{j=0}^{q} \left(\pi_{1j}^+ \Delta NEER_{t-j}^+ + \pi_{1j}^- \Delta NEER_{t-j}^- + \pi_{2j} \Delta Oil_{t-j} + \pi_{3j} \Delta FCP_{t-j} + \pi_{4j} Gap_{t-j} \right) + \nu_t \quad (4)$$

We use bound tests in order to ascertain the existence of cointegration. Banerjee et al. (1998) proposed t_{BDM} statistic to test the null hypothesis of $\rho_j = 0$. Pesaran et al. (2001) proposed F_{PSS} statistic for applying to the ARDL model, and Shin et al. (2014) demonstrated that we can use F_{PSS} for the Nonlinear Autoregressive Distributed Lag (NARDL) model. The null hypothesis of $\rho_j = \rho_c^+ = \rho_c^- = \rho_d = \rho_e = 0$ is tested against the alternative hypothesis of coefficients different to zero. The lower bound critical values are computed assuming that all variables are integrated of order zero, I(0), whereas the upper critical values are calculated upon the hypothesis that all variables are integrated of order one, I(1). If t_{BDM} and F_{PSS} are higher than the upper bound critical value, we may conclude on the existence of cointegration.

The ERPT is computed by the positive and negative long-run coefficients of the exchange

rate, which are defined as follow: $L_c^+ = -\rho_c^+/\rho_j$ and $L_c^- = -\rho_c^-/\rho_j$. Besides, the long-run coefficients of oil price and foreign competitor price are computed by $L_d = -\rho_d/\rho_j$ and $L_e = -\rho_e/\rho_j$. The short-run coefficients are those in first difference, π_{ij} $(i = 1, ..., 4)$. We expect a positive sign for L_c^+ and negative sign for the L_c^-.

Finally, the long-run symmetry can be tested by the Wald test of the null hypothesis of $L_c^+ = L_c^-$. To test the existence of short-run symmetry, we use the Wald test to test the null $\sum_{j=1}^{q} \pi_{1j}^+ = \sum_{j=1}^{q} \pi_{1j}^-$. If we reject the null hypothesis of symmetry, this implies that the model allows for asymmetric effects in both long- and short-runs. Otherwise, if we cannot reject the null hypothesis of symmetry, this means that the model should only allow for symmetric effects (i.e. linear ARDL).

When the null hypothesis of symmetry is rejected, we can compute the asymmetric dynamic multipliers of the positive and negative changes in the exchange rate as follow:

$$\begin{aligned} m_h^+ &= \sum_{j=0}^{h} \frac{\partial CPI_{t+j}}{\partial NEER_t^+} \\ m_h^- &= \sum_{j=0}^{h} \frac{\partial CPI_{t+j}}{\partial NEER_t^-} \end{aligned} \tag{5}$$

Where $h \to \infty$, $m_h^+ \to L_c^+$ and $m_h^- \to L_c^-$. The dynamic multipliers could capture the positive and negative shocks of the exchange rate on the consumer prices from an initial equilibrium to the new equilibrium (Shin et al., 2014).

4. Data and Results

4.1. Data

In this paper, we use quarterly data from 2000Q4 to 2018Q2[3]. Due to unavailability of NEER data, we computed NEER as the product of the weighted average of the bilateral nominal ex-

[3]The choice of this period is based on the availability of GDP in constant price (2010).

change rate between Vietnam and its top 20 major trading partners[4] as follows:

$$NEER_t = 100 * \prod_{i=1}^{20} S_{it}^{w_i} \tag{6}$$

Where S_{it} is the nominal exchange rate quoted by a number of local currency unit (VND) relative to 1 foreign currency unit of the trading partner *i*. w_i is their weights, and is normalized (equal to 1) by the shares of the trade share (sum of export plus import) of the 20 trading partners. S_{it}, w_i are normalized in base year 2000Q4.

We then compute trade-weighted foreign competitor price based on López-Villavicencio and Mignon (2017); Brun-Aguerre et al. (2017), is derived from the real effective exchange rate equation ($REER = NEER * P^*/P$) as $FCP = P^* = (REER * P)/NEER$ where P is Vietnamese consumer price index; *REER* is calculated by using *NEER* adjusted by relative price between Vietnam and its trading partners.

And the last variable, output gap (*Gap*) is the difference between actual and potential GDP, as a percentage of the latter, and is calculated as the standard formula:

$$Gap = \frac{GDP_{actual} - GDP_{potential}}{GDP_{potential}} * 100 \tag{7}$$

Where GDP_{actual} is the Gross Domestic Product in constant price (seasonally adjusted, 2010 price); $GDP_{potential}$ is computed from GDP_{actual} by using Hodrick - Prescott filter.

Bilateral nominal exchange rate (USD/VND) is taken from the State Bank of Vietnam whereas the GDP (constant price, 2010) is from General Statistics Office of Vietnam. Other variables are from Datastream Refinitiv. All variables are in logarithm and seasonally adjusted except the output gap.

[4]Main trading partners are: Japan, Singapore, China, Korea, US, Thailand, Hong Kong, Germany, Malaysia, France, Indonesia, UK, Netherlands, Russia, Philippines, Switzerland, Italy, Belgium, India and Canada. The trade weight of these countries is approximately 80% of total trade of Vietnam in 2017

Table 1: Unit root test

	Level	First Difference
$NEER^{+}$	-1.729	-4.581***
$NEER^{-}$	-0.128	-9.128***
Oil	-1.989	-6.314***
FCP	-0.106	-4.766***
Gap	-2.868*	

Notes: ***, * indicate significance at the 1% and 10% level

4.2. Results

In this section, we check whether all variables are either stationary I(0) or non-stationary I(1), as shown in Table 1. We then estimate an NARDL model of ERPT as shown in Table 2 and test for the existence of cointegration among all variables. Finally, we implement diagnostic and symmetry tests, as shown in Table 3.

First, we use the Augmented Dickey Fuller test based of the Schwarz information criterion to test unit roots, as presented in Table 1. According to Table 1, except the variable *Gap* that is stationary in level, all variables are stationary in the first difference, and are therefore I(1).

Second, we estimate the asymmetry exchange rate pass through in Equation (4) by using a general-to-specific approach to find the optimal lag. Estimations are displayed in Table 2. The results show that, for all variables, the long run pass-through coefficients are as expected and statistically significant except for the negative change in NEER (i.e. L_c^-). The exchange rate depreciation pass-through on consumer price is 0.861 and significant at the 1% level. This result indicates that a 1% depreciation of the nominal exchange rate will lead to an increase of 0.86% of domestic inflation. The high exchange rate depreciation pass-through level is consistent with Pham (2016) who found an ERPT of the same magnitude (0.84). Our finding is similar to ERPT of emerging markets (McCarthy, 2007; Mihaljek and Klau, 2001).

The elasticity of appreciation exchange rates appears to be weaker at around -0.396 but is not significant statistically. One possible explanation is when there is an appreciation of VND (i.e. depreciation of foreign currency), exporting firms do not change exports. Therefore, the

transmission of exchange rate to domestic price is less responsive.

The long run coefficient of foreign competitor price is 0.794 and significant at the 1% level. This means that a 1% rise of the price level of the major partners of Vietnam will lead to an increase of 0.794% of domestic inflation. The coefficient of foreign competitor price seems to be high, but it is coherent with economic features of Vietnam, and in line with theory. The first explanation is related to the exchange rate regime. Indeed, the exchange rate regime and the credibility of the central bank play an important role in the transmission of exchange rate variations. In fact, Vietnam follows crawling peg exchange rate regime suggesting that a change in exchange rate are usually interpreted as permanent so economic agents adjust their prices. As a result, the pass-through should be more pronounced (closed to full pass-through). The second argument is related to country size: As a small economy, Vietnam is considered as a price taker and not as a price maker. Therefore, the imports price of Viet Nam is set by the world market.

The variable that has less impact on consumer price index is oil price. Indeed, oil price long-run coefficient is around 0.068 which means that a 10% rise of oil price will be translated into a rise of 0.68% of domestic inflation.

In the short run, the response of domestic inflation to movements in the output gap is statistically significant and remains entirely coherent with economic theory. The coefficient is around 0.0018 which means that a 1% rise of the output gap might result in an increase of domestic inflation by 0.18%.The elasticity of oil price is negative -0.025 and significant statistically. This result is consistent with the short term policy of stabilizing petroleum price of Petroleum Price Stabilization Fund (PPSF). The PPSF is used flexibly to maintain the stability of domestic oil price in case of world oil price high volatility. The elasticity (pass-through) of positive exchange rate ($\Delta NEER^{+}_{t-1}$) is weaker in the short run. In fact, the coefficient is around 0.13 and significant at the 5% level. These results are in line with Jongwanich et al. (2019).

Another important finding of our study is that depreciation of exchange rate is more passed

Table 2: NARDL model estimation

Variable	Coefficient	Std. Error
CPI_{t-1}	-0.097**	0.037
$NEER^{+}_{t-1}$	0.084**	0.033
$NEER^{-}_{t-1}$	-0.038	0.048
Oil_{t-1}	0.0067	0.004
FCP_{t-1}	0.077**	0.03
ΔCPI_{t-1}	0.329***	0.072
ΔCPI_{t-4}	-0.212**	0.087
$\Delta NEER^{+}_{t-1}$	0.137**	0.055
ΔOil_{t-4}	-0.025***	0.008
ΔFCP_{t}	2.406***	0.288
ΔFCP_{t-4}	1.311**	0.495
ΔGap_{t-4}	0.0018***	0.0006
Adjusted	0.854	
Akaike info criterion	-8.74	
L^{+}_{c}	0.861***	0.151
L^{-}_{c}	-0.396	0.432
L_{d}	0.068*	0.036
L_{e}	0.794***	0.028

Notes: we go general-to-specific to find the best model by setting $p = q = 4$ for quarterly data. $L^{+}_{c}, L^{-}_{c}, L_{d}, L_{e}$ are respectively long-run coefficients of depreciation, appreciation of exchange rate, oil price and foreign competitor price. ***, **, * indicate significance at the 1%, 5% and 10% level.

through to domestic prices than appreciation, in both short and long run. This result is consistent with Delatte and López-Villavicencio (2012) and Brun-Aguerre et al. (2017). We attribute this finding to the fact that Vietnam is a price taker in the world markets. Therefore, following an appreciation, importer companies are less willing to decrease their prices in order to increase their mark-up (profits). On the other hand, following depreciation, importer companies tend to transmit (pass) shocks to domestic prices by increasing price selling in order to limit the reduction of their mark-up.

Third, diagnostic tests are applied to the estimations, including cointegration test, symmetry test, serial correlation in the residuals and heteroskedasticity test. The results are shown in Table 3. In Table 3, we use F-statistic upper bound critical value in Narayan (2005) and t-statistic

Table 3: Symmetry test, cointegration tests and diagnostic tests

t_{BDM}	F_{PSS}	LR - symmetry test	Serial Correlation LM Test	Heteroskedasticity Test
-2.62***	5.493***	18.472***	1.593 [0.191]	1.04 [0.427]

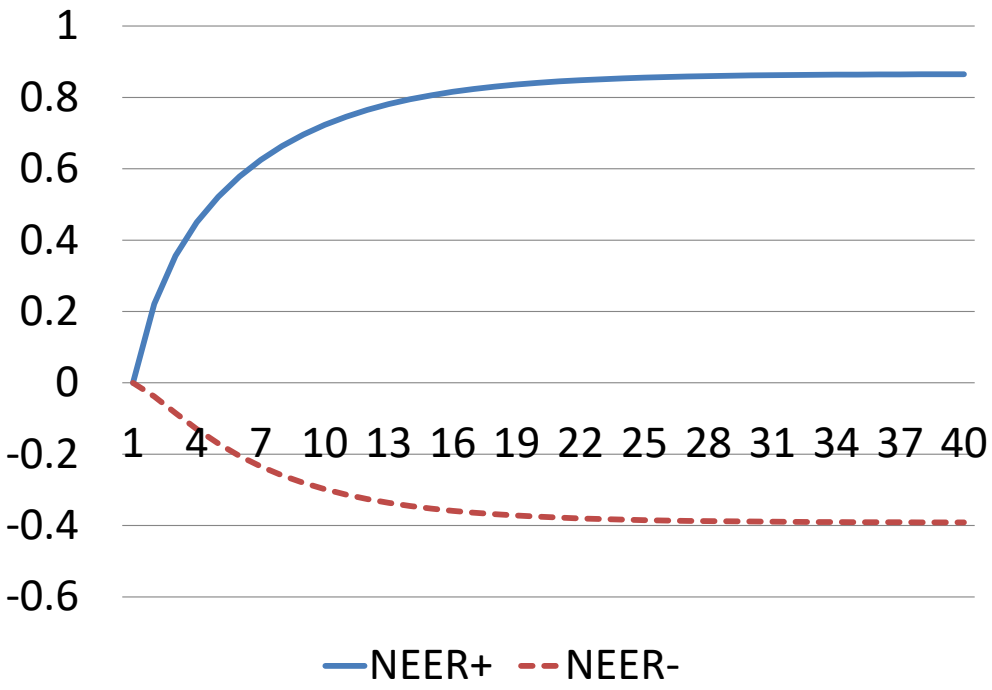
Notes: The F-upper critical values for the case restricted intercept and no trend in case N=70, K=5 are 4.717 (1%): 3.650 (5%) and 3.161 (10%) (see Narayan (2005); t-upper critical values for -4.44(10%); -3.83 (5%); -3.49(1%). *P*-value of Serial Correlation (Breusch-Godfrey) and Heteroskedasticity test(Harvey)are shown in [].

one in Pesaran et al. (2001) for the cointegration test (bound tests). Both F_{PSS} and t_{BDM} statistics exceed the upper critical values, confirming the existence of cointegration. We check the existence of asymmetry effect of exchange rate in long and short-runs by using Wald test. The long-run symmetry test is rejected at the 1% level, indicating the model allows the asymmetry effect of exchange in the long run. Only the positive change of NEER lag one ($\Delta NEER^{+}_{t-1}$) remains significant at the 5% level in the short-run (Table 2), implying that asymmetry effects of the exchange rate also apply in the short-run.

To sum up, exchange rate is pass through appears asymmetric in both long- and short-runs. This means that the linear ARDL is misspecified. Serial correlation and heteroskedasticity tests cannot reject the null hypothesis, indicating that our estimation is not spurious.

Finally, we show the dynamic multipliers in Figure 1 based on Equation (5). The dynamic multipliers up to 40 quarters. They show the new long-run equilibrium for the consumer price following the positive and negative shocks of the exchange rate from an initial long-run equilibrium. It is clear that the positive component of the exchange rate ($NEER^{+}_{t}$) has a stronger impact in the short- and long-runs. Indeed, depreciation of the exchange rate ($NEER^{+}_{t}$) tends to reach their long-run value within a few quarters. In contrast, appreciations tend to be less pronounced and less persistent.

Figure 1: Dynamic multipliers



5. Conclusion

In this paper, we have tried to measure the exchange rate pass-through on consumer price for Vietnam by using non-linear ARDL model over the quarterly period 2000Q4-2018Q2. We investigated the possibility of asymmetry in the reaction of domestic prices to variations of exchange rate. Our main results can be summarized as follows. First, the exchange rate still has an impact on domestic prices and depreciations are more strongly transmitted to CPI than appreciations, in both short- and long-runs. However, the pass-through is higher in the long-run than in the short-run. This finding is consistent with Delatte and López-Villavicencio (2012) and Brun-Aguerre et al. (2017). Second, the pass-through is very high in Vietnam (0.86). This could be explained by macroeconomic condition in Vietnam. Among Tiger countries, Vietnam

has one of the highest level of inflation. Indeed, from 2000 to 2018, the annual average of inflation in Tiger countries is around 4.39% against 6.59% for Vietnam. This finding is in line with Taylor (2000); Frankel et al. (2005) who argued that the decline in pass-through is due to a low inflation environment and is also influenced by the environment of transitory exchange rate fluctuations. In a nutshell, exchange rate movements are an important indicator for the State Bank of Vietnam in order to ensure price stability.

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