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Asymmetric exchange rates pass-through in Vietnam

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Abstract

In this paper, we study the measure of exchange rate pass-through on consumer price for Vietnam using the Nonlinear Autoregressive Dynamic Lag from 2000Q4 to 2018Q2. Our findings can be summarized as follows: (i) we demonstrate the existence of the asymmetric effect of the exchange rate to domestic price in both short run and long run; (ii) the exchange rate pass-through is high; (iii) the 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; and (v) foreign competitor price plays an important role in domestic price movement.

The views expressed herein are those of the author (Dung V. Tran) and do not necessarily reflect the views of the State Bank of Vietnam.
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1. Introduction

Assuring price stability through maintaining a moderate inflation rate is one of the most important missions of central banks in the world. Since the Bretton Woods agreement, economists has focused on the impact of exchange rates variation on consumer price indexes. The policy regime and central bank credibility are important factors for the exchange rate pass-through (thereafter, ERPT).

As an emerging market, Vietnam can be considered an interesting case study in macroeconomic stability, well-controlled inflation, and regulated monetary policy. Vietnam is amongst the fastest-growing countries in the world, at 6.5% annual rate over the 2000-2018 period. Besides the high economic growth, the inflation is changing through different stages. It surged to the 2-digit inflation in the crisis period of 2008 and 2011, and it was around 6% for the whole period from 2000 to 2018. Faced by high inflation pressure, the government sets stability price targeting and macroeconomic stability as a priority target. The State Bank of Vietnam (SBV – the central bank of Vietnam) used many monetary policy tools in order to control inflation.

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 orient exchange foreign market, and the exchange rate will move in a band setting by the central bank. Before 2015, the reference rate was the average of latest price trading. After 2015, the reference rate is calculated based on a 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 (Ho and Saadaoui, 2021).

There are several studies of ERPT in Vietnam, however the evidence is contrasting. Vo (2009) and Nguyen et al. (2009) pointed out a low-end ERPT, whereas Pham (2016) found a 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.

Contextualizing on these unsettled debates on the ERPT, this study contributes to the existing literature by focusing on the scale of the exchange rate pass-through into domestic prices in Vietnam during a long period from 2000Q4 to 2018Q2. Most of the existing studies on ERPT use the linear approaches, whereas this study refers to a novel

approach - the Non-Linear Autoregressive Distributed Lags (NARDL) estimator, developed by Shin et al. (2014), which accounts for the nonlinear and asymmetric aspects of ERPT. This methodology allows 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. In the other hand, it allows for analyzing the transmissions of exchange rate in both long run and short run. In addition, to the best of our knowledge, this is the first study on ERPT of Vietnam that takes into account the role of foreign competitor's price. By investigating the evidence on ERPT in a small but open and vibrant emerging country like Vietnam as a comparison to the previous literature which mostly concentrate on other developed countries, we believe this study is of interest to scholars and investors, as well as has profound implications for monetary authorities.

The remainder of this paper is organized as follows. Section 2 briefly reviews existing literature on the subject. Section 3 introduces the data employed and sets out a novel methodology to estimate ERPT in Vietnam. Section 4 discusses the results. Finally, section 5 draws the conclusion.

2. Literature review

There has been an extensive literature on exchange rate pass-through providing mixed evidence in different economies. For instance, Feinberg (1986) documents ERPT to domestic producer prices in the US and Germany to be higher in less concentrated industries. Goldberg and Knetter (1997) find ERPT to import prices are smaller in more segmented industries where firms are able to engage in third degree price discrimination. McCarthy (2007) shows 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) examine ERPT into import prices using quarterly data of 23 OECD countries from 1975 to 2003 and find compelling evidence of partial pass-through in the short run, especially within manufacturing industries. In the long run, producer-currency pricing is more prevalent for many types of imported goods. Countries with higher rates of exchange rate volatility have higher pass-through elasticities, although macroeconomic variables have played a minor role in the evolution of pass-through elasticities over time.

However, ERPT in the emerging market is higher than ERPT in advanced countries (Webber, 1999; Mihaljek and Klau, 2001; Ghosh, 2013). Some studies of ERPT

in ASEAN5 countries (Malaysia, Thailand, Singapore, Philippines, and Indonesia) were investigated by Cortinhas (2009); Siregar and Goo (2010); and Vo et al. (2021). However, 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) use 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) uses 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) tries 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 (Bhattacharya, 2014). 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; Camen, 2006; Le and Pfau, 2009). Therefore, we will not include money supply, credit, and the interest rate in our model.

The shortcomings of these studies can be summarized as follows: First, all models have used the 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 that the ERPT to consumer price could be asymmetric due to market share, capacity constraints, and other rigidities (quantity or export prices) (Marston, 1990; Knetter, 1994; Pollard and Coughlin, 2003).

The asymmetry in ERPT has been investigated in Delatte and López-Villavicencio (2012); Bussière (2013); El Bejaoui (2013); and Brun-Aguerre et al. (2017). Delatte and López-Villavicencio (2012) and El Bejaoui (2013) investigated an asymmetric non-linear ARDL to assess the ERPT to consumer price index/trade price for Japan, Germany, the United Kingdom, and the United States. Bussière (2013) analyzed the relationship between trade prices and exchange rate movements in the G7 economies. Brun-Aguerre et al. (2017) investigated asymmetry ERPT into import prices of 33 emerging and developed countries from 1980Q1 to 2010Q4.

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; to the best of our knowledge, this paper is the first one that capture the foreign competitor price for ERPT in Vietnam; (ii) to show the different magnitudes of appreciation and depreciation of the exchange rate to consumer price; (iii) to perform the ERPT in both short and long runs; and (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. Model

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 follows:

$$CPI_t = \alpha_0 + \alpha_1 NEER_t + \alpha_2 Oil_t + \alpha_3 FCP_t + \epsilon_t \quad (1)$$

where: *CPI* is consumer price index; *NEER* is the nominal effective exchange rate; *Oil* is the Brent oil price; *FCP* is the foreign competitor price; and ϵ_t is the error term. We used the NEER instead of the bilateral nominal exchange rate because it takes into account (any) shifts throughout the sample period with Vietnam's respective trading partners, unlike the nominal bilateral exchange rate. We computed NEER as the product of the weighted average of the bilateral nominal exchange rate between Vietnam and its

top 20 major trading partners[1] as follows: $NEER_t = 100 * \prod_{i=1}^{20} S_{¿}^{W_i}$ where $S_{¿}$ 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. $S_{¿}, W_i$ are normalized in the base year 2000Q4. 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 compute trade-weighted foreign competitor price based on Lopez and Mignon (2007) and Brun-Aguerre *et al.* (2016), which is derived from the real effective exchange rate equation ($REER = NEER * P^{¿}/P$) as $FCP = P^{¿} = \frac{REER * P}{NEER}$ where *P* is Vietnamese consumer price index; *REER* is calculated by using NEER adjusted by relative price between Vietnam (P) and its trading partners (P_i) as follows: $REER_t = 100 * \prod_{i=1}^{20} (S¿¿¿ * P/P_i)^{W_i}¿$. We expect a positive sign.

We hence use world oil price (*Oil*) 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 follows:

$$\Delta CPI_t = c_1 + \rho_j CPI_{t-1} + \rho_c NEER_{t-1} + \rho_d Oil_{t-1} + \rho_e FCP_{t-1} + \sum_{i=1}^{p} \varphi_i \Delta CPI_{t-i} + \sum_{j=1}^{q} (\pi_{1j} \Delta NEER_{t-j} + \pi_{2j} \Delta Oil_{t-}$$

[1] Vietnam's 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 was approximately 80% of the total trade of Vietnam in 2017.

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)) . *Gap* is output gap that is computed from GDP in constant price by using Hodrick–Prescott filter. 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 in 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 follows:

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

$$NEER_t^{-} = \sum_{j=1}^{t} \Delta NEER_j^{-} = \sum_{j=1}^{t} \min(\Delta NEER_j, 0);$$

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

$$\Delta CPI_t = c + \rho_j CPI_{t-1} + \rho_c^{+} NEER_t^{+} + \rho_c^{-} NEER_t^{-} + \rho_d \Delta OIL_{t-1} + \rho_e FCP_{t-1} + \sum_{i=1}^{p} \varphi_i \Delta CPI_{t-i} + \sum_{j=1}^{q} \theta_j \Delta NEER_{t-j} + \varepsilon_t \quad (4)$$

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 to be applied to the ARDL model. 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 follows: $L_{neer}^{+¿}=-\rho_e^{+¿/\rho_j}¿$ and $L_{neer}^{-¿}=-\rho_e^{-¿/\rho_j}¿$. Besides, the long-run coefficients of oil price and foreign competitor price are computed by $L_{oil}=-\rho_d/\rho_j$; $L_{FCP}=-\rho_e/\rho_j$. The short-run coefficients are those in the first difference, $\pi_{ij}(i=1,\ldots,4)$. We expect a positive sign for $L_{neer}^{+¿¿}$ and a negative sign for the $L_{neer}^{-¿¿}$.

The long-run symmetry can be tested by the Wald test of the null hypothesis of $L_{neer}^{+¿}=L_{neer}^{-¿¿}¿$. To test the existence of short-run symmetry, we use the Wald test to test the null $\sum_{j=1}^{q}\pi_{1i}^{+¿}=\sum_{j=1}^{q}\pi_{1i}^{-¿}¿¿$. 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 follows:

$$m_h^{+¿}=\sum_{j=0}^{h}\frac{\partial CPI_{t+j}}{\partial NEER_{t+j;\,m_h}^{+¿}}¿ \quad (5)$$

where $h\to\infty, m_h^{+¿}\to L_{neer}^{+¿;m_h}¿$. 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 2000Q4-2018Q2[2]. 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.

4.2 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

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

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 on the Schwarz information criterion to test unit roots, as presented in Table 1. According to Table 1, except for the variable *Gap* that is stationary in level, all variables are stationary in the first difference.

[Insert Table 1 here]

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, in which Panels A and C show the short-run and long-run estimations, respectively, whereas Panel B presents the cointegration vector estimations.

Panel A in Table 2 shows the short-run estimated coefficients. The elasticity (pass-through) of positive exchange rate $NEER_t^{+¿¿}$ is weak 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). This result reflects that an increase of 1% of depreciation of the nominal effective exchange rate leads to an increase of 0.13% of domestic inflation in the short run. However, the effect of appreciation of NEER on domestic inflation is omitted in the short run. This can be explained by the permanent depreciation of VND for a long period.

The response of domestic inflation to movements in the output gap is statistically significant in the short run, 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%. This finding suggests that output gap drives inflation in the short run, and the government should be cautious about GDP growth rate target.

The elasticity of oil price (-0.025) is negative and statistically significant. This result may be surprising but is consistent with the objectives of the Vietnamese Petroleum Price Stabilization Fund (PPSF). The aim of the PPSF is to act as a shock absorber to maintain the stability of domestic oil price in the event of high oil price volatility. Thus, the PPSF allows a slow and gradual adjustment of consumer prices,

which makes domestic prices (CPI) less responsive to variations of oil price. Consequently, the slight negative effect of oil price, in the short run, on domestic consumer price seems obvious.

Panel C presents the long-run estimated coefficients. 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_{neer}^{-ii}). The exchange rate depreciation pass-through on consumer price is 0.861 and significant at the 1% level. This result indicates that a 1% increase of 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 (Mihaljek and Klau, 2001; McCarthy, 2007). The possible 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 is 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 elasticity of appreciation exchange rates appears to be weaker at around -0.396 but is not statistically significant. 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.

[Insert Table 2 here]

Most interestingly, 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 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 Vietnam is set by the world market, and this variable plays an important role in the movement of the domestic price.

The variable who 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. As we explained above, the intervention of PPSF will absorb shocks in world oil price in order to maintain the stability of domestic oil price. Therefore, the impact of oil price on inflation is small.

Another important finding of our study is that depreciation of the exchange rate is more passed through to domestic prices than appreciation, in both short run and long run. This result is consistent with Delatte and Lopez (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 the prices 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, heteroskedasticity tests, and CUSUM test. The results are shown in Table 3. In Table 3, we use the F-statistic upper bound critical value in Narayan (2005) and the t-statistic 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 the 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 that 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 pass-through appears to be 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. We test structural break by CUMSUM test (cumulative sum of residuals)[3]. The coefficients for the specification describing the dynamics of CPI seem to be stable over the sample period.[4]

[Insert Table 3 here]

[3] We thank an anonymous referee for this remark.
[4] The result is available upon request.

The dynamic multipliers up to 40 quarters are presented in Figure 1 based on Equation (5). 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 than negative one $NEER_t^{-¿¿}$ in both short and long run effects. Indeed, depreciations of the exchange rate $NEER_t^{-¿¿}$ tend to reach their long-run value within a few quarters. In contrast, appreciations tend to be less pronounced and less persistent.

[Insert Figure 1 here]

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 foreign competitors price plays an important role for domestic price movement. Finally, the pass-through is high in Vietnam. This could be explained by macroeconomic conditions in Vietnam. Among Tiger countries, Vietnam has one of the highest levels 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) and 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 the policy setting, these results suggest that movements of exchange rate and foreign competitors price are important indicators for policymakers and the State Bank of Vietnam in order to ensure price stability.

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: * and *** means the significant at the 10% and 1% level.*

Table 2. NARDL model estimation

Panel A: Short-run coefficients					
Variable/Lag order	0	1	2	3	4
ΔCPI		0.329***			-0.212**
		(0.072)			(0.087)
$\Delta NEER^{+}$		0.137**			
		0.055			
$\Delta NEER^{-}$					
ΔFCP	2.406***				1.311**
	(0.288)				(0.495)
ΔOil					-0.025***
					(0.008)
Gap					0.0018***
					(0.0006)

Panel B: Cointegration vector (ECM form)			
$NEER^{+}_{t-1}$	$NEER^{-}_{t-1}$	Oil_{t-1}	FCP_{t-1}
0.084**	-0.038	0.0067	0.077**
(0.033)	(0.048)	(0.004)	(0.03)

Panel C: Long-run coefficients			
L^{+}_{neer}	L^{-}_{neer}	L_{oil}	L_{FCP}
0.861***	-0.396	0.068*	0.794***
(0.151)	(0.432)	(0.036)	(0.028)

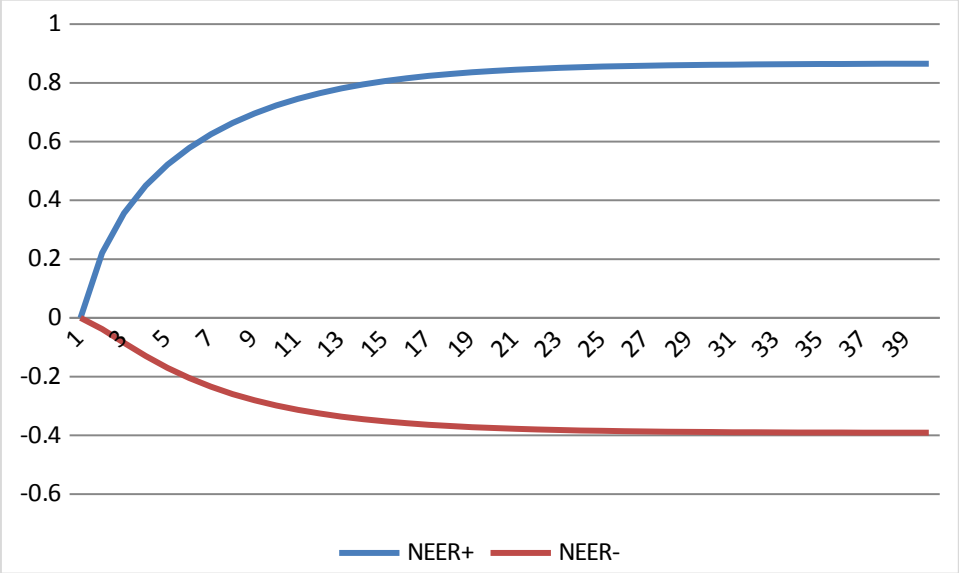
Notes: We go general-to-specific to find the best model by setting p=q=4 for quarterly data. $L^{+}_{neer}, L^{+}_{neer}, L_{oil}, L_{FCP}$ *are long-run coefficients of depreciation, appreciation of exchange rate, oil price and foreign competitor price, respectively.*

Table 3. Symmetry test, cointegration tests, and diagnostic tests

ECM	Adj–	AIC	t_{BDM}	F_{PSS}	LR- symmetry test	Serial correlation	Heteroskedasticity test
-0.097**	0.854	-8.740	-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 [].

Figure 1. Dynamic multipliers



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