Nonlinear exchange rate pass-through to inflation in Vietnam: a TVAR model approach

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ABSTRACT: The study analyses nonlinear exchange rate pass-through (ERPT) to inflation in Vietnam with monthly basis of inflation rate as a threshold variable. By employing threshold vector autoregression (TVAR) model and monthly data in period 2008-2015, the study finds nonlinear form of ERPT with two threshold values of month-on-month inflation at 0.336 percent and 0.620 percent. ERPT to inflation is significantly complete at 1 percent after 7 months when inflation rate is above the latter but negligible or insignificant when inflation rate is below the latter. Exchange rate fluctuation is one of determinants of inflation at various contributions depending on the level of inflation.

KEYWORDS: exchange rate pass-through (ERPT), threshold vector autoregression (TVAR), nonlinearity, Vietnam.

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1. Introduction

Many empirical studies indicate that exchange rate pass-through (herein ERPT) decreases when inflation is lower and more stable (Campa & Goldberg, 2002; Gagnon & Ihrig, 2004). While most studies did not exceed the assumption of linear ERPT, Taylor (2000) was the first one who found the nonlinear ERPT to inflation which depends on the degree and fluctuation of inflation. He indicates that ERPT does not occur when inflation is low but when inflation is high. The nonlinear ERPT has been clarified by many later studies, such as Shintani, Terada-Hagiwara & Yabu (2013), Aleem & Lahiani (2014) by identifying the threshold level of inflation at which ERPT changes.

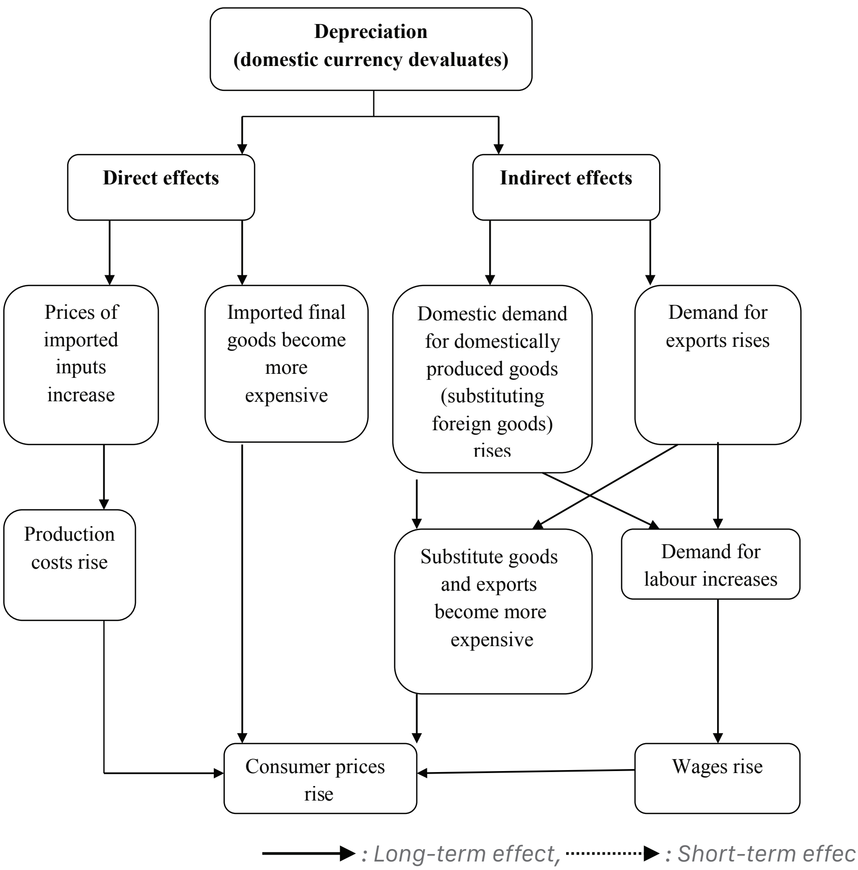
With the increasing integration of Vietnam economy to the global economy, it is more challenging to implement monetary policy with inflation targeting/target because of the unpredictable exchange rate fluctuations. Hence, ERPT is an essential indicator to forecast inflation and conduct monetary policy of the State Bank of Vietnam (SBV). However, most studies of ERPT in Vietnam are still based on the assumption of linear relationship. Although there are some studies of ERPT using the nonlinear approach, they have not yet identified the threshold level of inflation (Pham Thanh Chung, 2015). The recent study of Tran Ngoc Tho & Nguyen Thi Ngoc Trang (2015) helps to fulfill the mentioned research gap but it does not show how inflation changes when there is an exchange rate shock in different inflation environments. Therefore, our study aims to clarify the nonlinear ERPT in Vietnam by analyzing the degree of ERPT in different inflation environments. We employ a vector autoregression (VAR) approach in order to identify (i) the threshold level of inflation at which ERPT changes in Vietnam; (ii) how ERPT degree changes in each inflation environment.

2. Literature review

ERPT is defined as the percentage change of import prices denominated in local currency resulting from a one percent change in the exchange rate between the export and import countries (Goldberg & Knetter, 1997). ERPT is considered "complete" when a one percent change in the exchange rate results in a one percent change in the import prices and "incomplete" when a one percent change in the exchange rate results in less than one percent change in the import prices. As the change in import prices also partially transmits to production prices and consumer prices (McCarthy, 2000), the definition of ERPT is wider than the change of domestic price indices affected by the change of nominal exchange rates (Goldberg et al, 1997).

The transmission mechanism of ERPT in an open economy with free capital flows and flexible exchange rate is described in Figure 1. Direct channels of the transmission show the impacts of exchange rates to inflation through import prices. While exchange rate depreciates, higher prices for imported goods create an increase in both prices of imported consumer goods and costs of imported inputs for domestic production. As a result, the prices of consumer goods rise.

Figure 1: ERPT mechanism to consumer prices



Source: Lafleche (1996).

Indirect channels of transmission show an effect on the competitiveness of domestic goods in the global markets. Exchange rate depreciation generates an increase in the competitiveness of domestic goods, domestic demand (in order to substitute the more expensive imported goods) and external demand for domestically produced goods. Then demand for labour increases, wages rise and as a result, inflation increases. However, this effect is only available in long-run due to the "rigidity" of prices in short-run (imported contracts are usually signed before shipping).

Taylor (2000) finds that ERPT can be varied in different inflation environments. Using staggered pricing model with market power and a sample of United States' firms during 1988-1999, he proves that when inflation is stable at a low level and firms set products as expected, prices will not adjust much to (the changes of…) due to low inflation expectations in the future.

Later studies clarify Taylor's hypothesis (2000) in two ways. Firstly, studies for many economies show that the difference of ERPT among economies is due to inflation environments. Conducting a research for 144 countries during 1970-2007, Devereux & Yetman (2008) use the Keynesian macroeconomic model and indicate that ERPT in countries with high inflation is higher than ones with low inflation. Campa et al (2002) carry on a research of the ERPT using data among countries in the Organization for Economic Co-operation and Development (OECD) over the period from the first quarter of 1975 to the fourth quarter of 1999 and a vector error correction model (VECM). The results show that inflation has an impact on the degree of ERPT, with a 1% increase in inflation, ERPT only increases by 0.23%. Thus, Campa and Goldberg conclude that ERPT has been declining over time only in low-inflation countries, and it is not a prevalent feature in OECD countries. Using data of 71 industrial and developing economies during 1979-2000, Choudhri & Hakura (2006) also find that the level of transmission is higher in high inflation environments. In addition, they present that when inflation increases by 10%, ERPT increases by 5% in the short-run and by 6% in the long-run. As controlling inflation is one of the objectives of the monetary policy, they argue that the relationship between inflation and ERPT implies that the monetary policy also affects ERPT. Gagnon et al (2004) add that a country with a reliable inflation control policy generally has a lower rate of exchange rate transmission.

The second way of research is to examine the changes of ERPT in each economy, depending on the inflation in each period. Those studies then set out the hypothesis of nonlinear ERPT to prices based on the price movements themselves.

Shintani et al (2013) estimate smooth transition autoregressive (STAR) models with inflation variable as a transition variable in the United States, using the U-shaped transition function to estimate ERPT on data from January 1975 to December 2007. The results show that ERPT decreases throughout the 1980s and 1990s, associating with low inflationary environment.

Junttila & Korhonen (2012) study 9 developed economies of the OECD from the first quarter of 1975 to the fourth quarter of 2009 using the exponential STAR (ESTAR) model for Italy, the United Kingdom, and Sweden; logistic STAR (LSTAR) for Denmark and threshold autoregression (TAR) for the remaining countries including the United States, Germany, Canada, Spain and Australia. The result shows that the average threshold of annual inflation rate is 2.92%; when the inflation rate is below this threshold, ERPT to import price does not occur but strongly does when inflation is higher than the threshold rate of 0.71%.

Compared to developed economies, the inflation thresholds in developing economies are usually higher. Alvarez, Gonzalez-Rozada, Neumeyer & Beraja (2015) employ the menu cost model for Argentina's data during 1988-1997. They find that exchange rate fluctuations do not affect inflation when inflation is less than 10%, but when inflation is 10% or higher, the transmission degree is in the range from 1/2 to 2/3. Aleem et al (2014) provide additional evidence of nonlinear ERPT in Mexico using the TVAR model and data from January 1994 to November 2009. They indicate that ERPT is high in a high inflationary environment (inflation rate > 0.783% per month); low in a low inflationary environment (inflation rate <0.167% per month) and at average level in average inflationary environment (0.167% per month < inflation rate ≤ 0.783% per month).

In Vietnam, ERPT has been explored in many studies by a variety of methods such as VAR, SVAR and VECM in different periods. Most studies have shown that ERPT to consumer prices is not complete, of those only a small number of researches consider inflation environments. Pham Thanh Chung (2015) uses the STAR model for the period 1995-2012 and shows a higher the level of ERPT is associated with high inflation and vice versa. ERPT begins to occur when inflation rises by 1 unit and increases to almost 1 when inflation rises from 2.5 to 4 units.

Tran Ngoc Tho et al (2015) publish a research on the transmission of exchange rates to domestic price index under the influence of inflation environment from January 2000 to December 2014. They use a TVAR model and find two inflation thresholds of 0.1595% per month and 0.3395% per month. Under the threshold of 0.3395%, inflation is almost negligible and above this level, inflation rises and then returns to equilibrium. However, the impulse responses estimates in this study raise a debate about statistical significance.

3. Data and methodology

3.1. Methodology

- **TVAR Model**

We employ TVAR model for its three main advantages. First, for its simplicity, TVAR model is sufficient to explain the potential nonlinearities such as transition regimes and asymmetric effects of shocks. The reason is that the effects of shocks depend on their magnitude and directions (whether they are in the same or opposite directions). Second, the variables in each state of TVAR model could also be endogenous variables like in VAR model. Thus, the regime transitions (effects of shock to other variables in the systems) could happen after the shock to each variable. Third, although the coefficients in each state of TVAR model are estimated easily using the OLS method, two assumptions made for the TVAR model are nonlinearity and asymmetric impulse responses. The TVAR models divide time-series variables into different regimes by threshold variables, which could be either endogenous or exogenous ones (Hansen, 1999). In each regime, a time-series is described as a reduced form VAR with p lags.

$$Y_t = \phi X_t + e_t \tag{1}$$

Of which: Y_t - vector of endogenous variables and $X_t = (1, Y_{t-1}, ..., Y_{t-p})'$; $\phi = (\phi_0, \phi_1, ..., \phi_p)$ includes ϕ_0 - vector of constant; ϕ_i - matrix of autoregressive coefficients with i=1, ... p; e_t - vector of residuals with zero mean and serially uncorrelated; p - the number of lags.

We follow Baum & Koester (2011) to assess the ERPT for Vietnam using TVAR approach by developing 2 models that are one-threshold model (2-state model) and two-threshold model (3-state model) before choosing the most appropriate model for Vietnam. According to the mentioned transmission mechanism of ERPT, the one-threshold TVAR model (model 2) includes Y_t = [CPI, YGAP, NEER, M2] which are inflation (CPI), output gap (YGAP), nominal effective exchange rate (NEER) and money supply (M2). Model 2 can be written as follow:

$$Y_t = \phi_1 X_t + \phi_2 X_t I(z_{t-d} \geq z^*) + e_t \tag{2}$$

Of which: ϕ_1 and ϕ_2 are 4x4 matrices of coefficients of state 1 and state 2 respectively; $X_t = (1, Y_{t-1}, ..., Y_{t-p})'$, e_t - is a *4x1* vector of residuals with zero mean;

Σ_e is the variance-covariance matrix; z^* is are the critical threshold value; d is the number of lags for threshold variable. The indicator function I(.) is 1 if conditions are met otherwise it is 0. Baum & Koester (2011), Aleem et al (2014) also assume that the number of lags in two states is equal.

Similarly, the two-state TVAR model (model 3) has two threshold variables which are z_1 and z_2 respectively.

$$Y_t = \phi_1 X_t I(z_{t-d} \leq z_1) + \phi_2 X_t I(z_1 < z_{t-d} \leq z_2) + \phi_3 X_t I(z_{t-d} > z_2) + e_t \tag{3}$$

Like the linear VAR model, the TVAR model at order p is estimated and selected based on testing standards. That is the inverse roots of the characteristic VAR polynomial should be less than one and lie inside the unit circle, ensuring the model's stability.

• **TVAR model estimation**

According to Stigler (2010), the value of threshold is defined as sum of squared residuals (SSR) in all regimes.

$$\hat{z}^* = \underset{z \in C}{\arg\min}\, SSR(z) \tag{4}$$

Of which: $SSR(z) = \sum_{i=1}^{q} SSR_{(i)}(z)$, with i=1, ..., q - number of regimes, argmin function - the value of z which minimizes SSR(z).

Before estimating TVAR models, we test the nonlinearity using the extended multivariables test of Lo & Zivot (2001) based on testing for a threshold of Hansen (1999) with a bootstrap distribution in order to ensure the suitability of observation data. Then, the likelihood ratio (LR) is used to estimate the variance-covariance matrix in each model. In this paper, the bootstrap sample is 1000 (Hansen & Seo, 2002) and the trimmed value is 0.15 (Hansen, 1996), employed to fit our data.

ERPT to consumer prices is measured by the impulse response functions (IRF). Since the Cholesky decomposition in VAR depends on the order of the variables, we adopt the generalized IRF (GIRF). Furthermore, in this paper, we also implement the variance decomposition to recognize the importance of exchange rate in inflation movements that cannot see in GIRF. The main limit of this study is that as the number of regimes and threshold variables is selected in our assumption, shocks that occur in one regime do not create a contagious effect to another regime, rather than only available within that regime.

3.2. Data

Variables used in the model are represented and calculated from specific sources as follow:

• Inflation (CPI) is presented by the consumer price index. The monthly consumer index data is colected from International Financial Statistics (IFS) database of International Monetary Fund (IMF) with the base year of 2010.

• Output gap (YGAP) represents for aggregate demand of an economy. It is the difference between the natural logarithm of the actual value of industrial production in a given period and the natural logarithm of the potential value of industrial production of the economy (given by the formula (6)). Potential industrial production (IP^p) is calculated using Hodrick-Prescott (HP) filter for the actual value of industrial production with parameter $\lambda = 1600$ (Jaffri, Asjed & Bashir, 2013). Value of industrial production is obtained from General Statistic Office (GSO) database and adjusted to the base year of 2010 under the guidance of Circular 02/2012/TT-BKHDT.

$$YGAP = (\ln(IP_t) - (\ln(IP_t^p)) \quad (6)$$

• Nominal effective exchange rate (NEER) is calculated based on exchange rate between Vietnam Dong (VND) and a basket of multiple foreign currencies of 17 countries, namely Russia, Canada, Brazil, Australia, Hong Kong, Japan, Korea, Singapore, Switzerland, United Kingdom, United States, China, Indonesia, India, Malaysia, Philippines and Thailand. These countries have the largest trade values with Vietnam (accounting for more than 80% of Vietnam's total annual import-export turnover). NEER is calculated according to the geometric mean (GM) formula (given by the formula (7)).

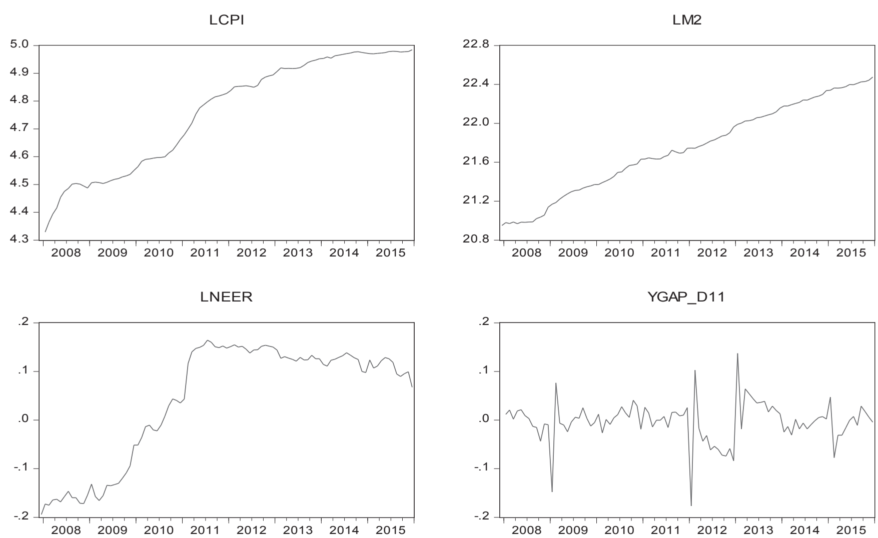
$$NEER_t = \Pi_{i=1}^{17} (e_{it})^{\omega_{it}} \quad (7)$$

Of which: e_{it} - bilateral nominal exchange rate, calculated by ratio of VND and i currency with i = 1,2,...,17 at time t (in index); ω_i - the weight of currency i at time t corresponds to the proportion of trade value of country i in the total trade volume of 17 mentioned countries with Vietnam. NEER also has the base year of 2010 taken from various sources: (i) bilateral nominal exchange rate against the US dollar of Vietnam and trading partners is the average exchange rate taken from IFS; (ii) monthly trade values of trading partners with Vietnam are collected from Direction of Trade Statistics (DOTS) of IMF.

• Money supply (M2) is collected from IFS, representing monetary policy, as M2 is one of SBV's intermediate objectives in conducting monetary policy.

All data are collected from January 2008 until December 2015 as there is a huge and complex fluctuation of exchange rate and inflation of the economy in this period. In addition, YGAP series are adjusted for seasonality by the Census X-13 method, while the rest of the series are in natural logarithmic forms. Figure 2 shows the evolution of variables after processing and Table 1 shows more statistics describing the variables.

Figure 2: Data in the model



Source: Authors' calculations.

Table 1: Variables' statistics

	LCPI	LM2	LNEER	YGAP_D11
Mean	4.760	21.749	0.044	-0.003
Median	4.833	21.744	0.115	0.002
Maximum	4.985	22.476	0.164	0.137
Minimum	4.329	20.969	-0.175	-0.177
Standard deviation	0.199	0.453	0.120	0.042
Number of observations	96	96	96	96

Source: Authors' calculations.

Since each equation in each TVAR regime is estimated by OLS, this study performs a pause test to ensure the accuracy of the estimates. The results of the ADF and PP unit root tests in Table 2 show that CPI, REER and M2 are all I (1), except YGAP is I (0). Thus, in the estimation, we use the level series of YGAP and first differenced series for other variables.

Table 2: Unit root test results

Variables	ADF test	Reject unit root at 1%	PP test	Reject unit root at 1%
LCPI	-16.527	-35.014	-2.7945*	-35.007
YGAP_D11	-3.5761***	-35.022	-10.1291***	-35.007
LNEER	-22.889	-34.999	-21.869	-34.999
LM2	-0.7783	-34.999	-0.7535	-34.999
D(LCPI)	-4.8330***	-35.014	-4.7321***	-35.014
D(LNEER)	-7.4217***	-35.007	-7.3731***	-35.007
D(LM2)	-9.0765***	-35.007	-9.1075***	-35.007

, ** and * are the statistical significance levels of 10%, 5% and 1%, respectively.*
Source: Authors' calculations.

4. Results

4.1. Inflation thresholds

Table 3 shows that our VAR model (which has the endogenous vector Y is defined as in model (2)) should be estimated with 2 lags based on the criteria of LR, FPE and AIC. The stability test for VAR model also passes with all the inverse roots lie inside the unit circle. In the next step we estimate TVAR at the order of 2 lags.

Given the number of lags for threshold variable is equal and/or less than 2 (d 2), we use information criteria to choose the appropriate number of regimes for both TVAR (2) and TVAR (3) models. As shown in table 4, AIC and SSR criteria suggest us that a 3-regime TVAR model with 2 lags of threshold variable is selected.

We test the nonlinearity with 2-lag threshold variables using 94 observations (because our model's optimal lag length is 2). As presented in table 5, the linearity hypothesis is rejected in both 2-regime and 3-regime TVAR models. In addition, the test also rejects the hypothesis that the TVAR model has 2 regimes at 5% significance level.

Table 3: Lag length criteria test for VAR model

Number of lags	LR	FPE	AIC	SC	HQ
0	NA	4.33e-15	-21.721	-21.609*	-21.676
1	62.005	2.95e-15	-22.105	-21.542	-21.878*
2	33.185*	2.80e-15*	-22.161*	-21.148	-21.753
3	15.301	3.30e-15	-22.002	-20.538	-21.412
4	11.402	4.09e-15	-21.799	-19.884	-21.027
5	19.434	4.48e-15	-21.725	-19.360	-20.772
6	20.183	4.81e-15	-21.682	-18.867	20.548
7	17.134	5.37e-15	-21.608	-18.343	-20.293
8	12.681	6.46e-15	-21.475	-17.759	-19.978

**The optimal lag length is selected based on the following criteria: LR: sequential modified LR test statistic (at 5% significance level); FPE: Final Prediction Error; SC: Schwarz information criterion; AIC: Akaike Information Criterion; HQ: Hannan-Quinn Information Criterion.*

Source: Authors' calculations.

Table 4: TVAR model selection criteria

Model		AIC	BIC	SSR
2-regime TVAR model				
Threshold variable's lag length	1	-3141.421	-2955.761*	0.138
Threshold value	0.00053			
Threshold variable's lag length	2	-3134.284	-2948.624	0.141
Threshold value	0.00549			
3-regime TVAR model				
Threshold variable's lag length	1	-3118.545	-2838.783	0.098
Threshold values	0.00271 and 0.00544			
Threshold variable's lag length	2	-3153.476*	-2873.714	0.093*
Threshold values	0.00336 and 0.00620			

** Minimum value.*

Source: Authors' calculations.

Table 5: LR test results

LR test for linearity in VAR and 2-regime TVAR models	
LR statistics	85.479
P_value	0.030
LR test for linearity in VAR and 3-regime TVAR models	
LR statistics	150.965
P_value	0.056
LR test for linearity in 2-regime TVAR and 3-regime TVAR models	
LR statistics	65.486
P_value	0.000

Source: Authors' calculations.

Combining with the results in Table 4, a 3-regime TVAR model that has 2 critical threshold values of 0.336% per month and 0.620% per month is selected. This model identification is also adopted in the earlier study of Tran Ngoc Tho et al (2015), again enhancing the appropriateness of 2-regime TVAR model identification for Vietnam data. Our threshold values, however, are much higher than earlier estimations. For example, in comparison with Mexico's case, our lower threshold value is higher but the upper one is lower. Furthermore, our estimated threshold values are also larger than that in developed countries. Again, it could be said that the inflation thresholds in developed countries are often lower than that in developing countries thanks to their low and stable inflationary environments.

4.2. ERPT degrees in different inflation environments of Vietnam

Table 6 reports the summarized results of Granger causality test. The test's results suggest that we can reject the hypothesis that NEER does not Granger cause CPI at 1% significance level. However, we cannot reject neither the hypotheses that NEER does not Granger cause M2 and NEER does not Granger cause YGAP nor the hypotheses that M2 does not Granger cause CPI and YGAP does not Granger cause CPI. Hence, we measure ERPT degrees in different inflation environments using GIRF.

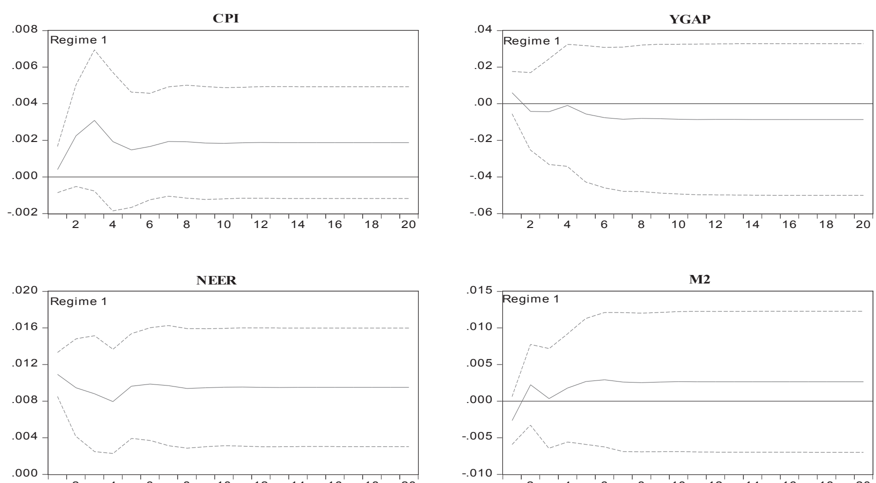
According to the analysis of generalized impulse response functions, in the low inflation environment (inflation ≤ 0.336%/month), the responses of CPI, YGP, M2 and NEER to a one-standard deviation shock of NEER are statistically

Table 6: Granger causality test

Hypothesis	F statistics	Prob
DLM2 does not Granger cause DLCPI	0.561	0.573
DLCPI does not Granger cause DLM2	3.995	0.022
DLNEER does not Granger cause DLCPI	10.295	0.000
DLCPI does not Granger cause DLNEER	0.798	0.453
YGAP_D11 does not Granger cause DLCPI	0.093	0.912
DLCPI does not Granger cause YGAP_D11	0.763	0.469
DLNEER does not Granger cause DLM2	1.184	0.311
DLM2 does not Granger cause DLNEER	0.072	0.931
YGAP_D11 does not Granger cause DLNEER	0.410	0.665
DLNEER does not Granger cause YGAP_D11	0.093	0.911

Source: Authors' calculations.

Figure 3: Accumulated responses to generalized one S.D. innovation in NEER when inflation is low



Source: Authors' calculations.

significant (Figure 3). CPI moves in line with NEER, accumulating to the highest point of 0.31% after 3 months, then slightly falling down in the 4th month to 0.15% at the 5th month before setting a new equilibrium of increase by 0.19% from the 7th month as compared to it before the shock. This result suggests that when inflation is low, the response of inflation to a one standard deviation shock of exchange rate supports the theory. In particular, the initial response of price is to increase following an exchange rate's depreciation. It could be explained by the "rigidity" price of signed importing contracts in short-run. However, there are then market adjustments conducted by importers, decreasing import prices and creating a new equilibrium for price - lower than the highest price that increases due to the change of exchange rate. Moreover, according to Goujon (2006), there is a dollarization in Vietnam, in which the prices of some non-tradable goods are denominated in dollar, such as real estates, high value fixed assets, and long-term contracts, so that the increasing price effect after depreciation is more exaggerated in short-run. Thus, in this study, it is reasonable that inflation goes up to its highest point in the first 3 months.

Following the NEER shock, M2 increases as well and stays at its new equilibrium, reflecting an expansionary monetary policy to stimulate production when demand for domestic goods increases, in order to substitute imported goods and expand exports. In addition, the increase in money supply partially reflects the exaggerated effect of dollarization on ERPT. This finding is also found in Vo's paper (2009). In contrast, YGAP negligibly decreases in response to NEER shock.

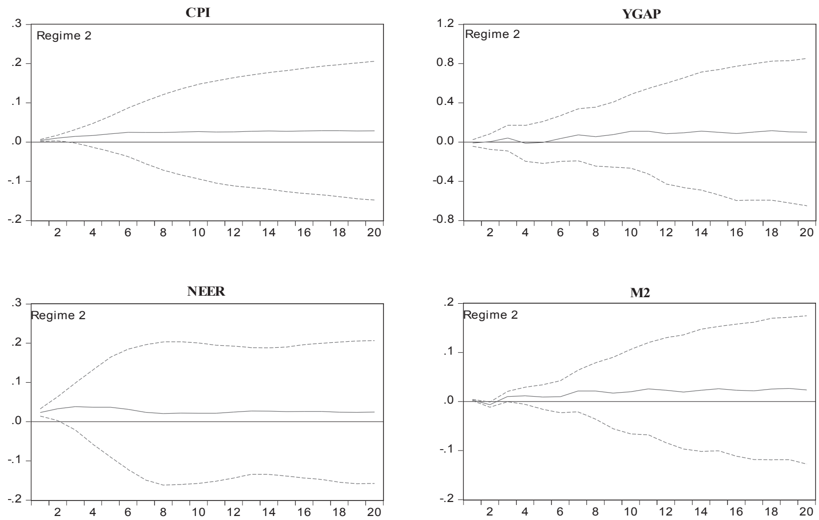
In the average inflation environment (inflation rate is in the range between 0.336%/month to 0.62%/month), the responses of all other variables (CPI, YGAP, and M2) to the shock of NEER are statistically insignificant (Figure 4).

In the high inflation environment where inflation rate is larger than 0.62%/month, a one standard deviation innovation in NEER causes a gradual increase in CPI. Particularly, it rises up to 0.3% after 2 months and complete at 1% from the 7th month (Figure 5). Hence, it could be said that, when inflation is high, ERPT in Vietnam is stronger on grounds of high inflation expectations in the future.

The response of YGAP to a NEER's shock is similar as in the case of low inflation environment, i.e. YGAP goes down but the magnitude of the effect is negligible after the shock of depreciation. In contrast, M2 falls sharply rather than slightly increase as in the case of low inflation environment. It could be explained that monetary policy is more sensitive when inflation is high and immediately tightened when inflation rises as a result of ERPT. The response of M2 to CPI shock in figure 2 helps to visualize this argument. After the shock to CPI, M2 declines to its new equilibrium with a decrease of 1.2% after 7 months.

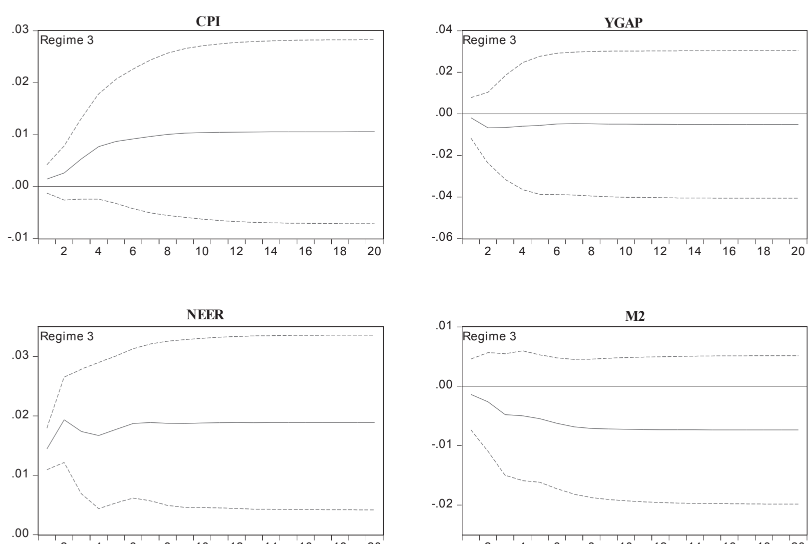
In short, the degrees of ERPT are different when inflation environments change. ERPT is strongest and complete in a high inflationary environment.

Figure 4: Accumulated responses to generalized one S.D. innovation of NEER when inflation is average



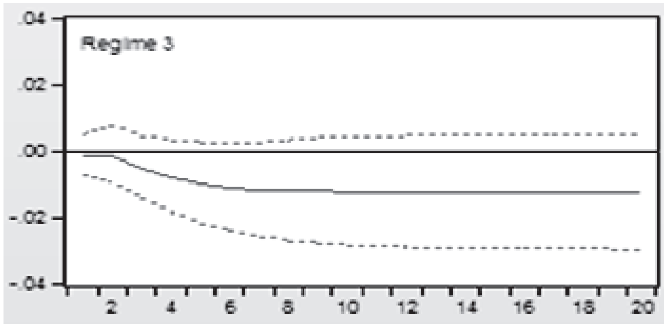
Source: Authors' calculations.

Figure 5: Accumulated responses to generalized one S.D. innovation of NEER when inflation is high



Source: Authors' calculations.

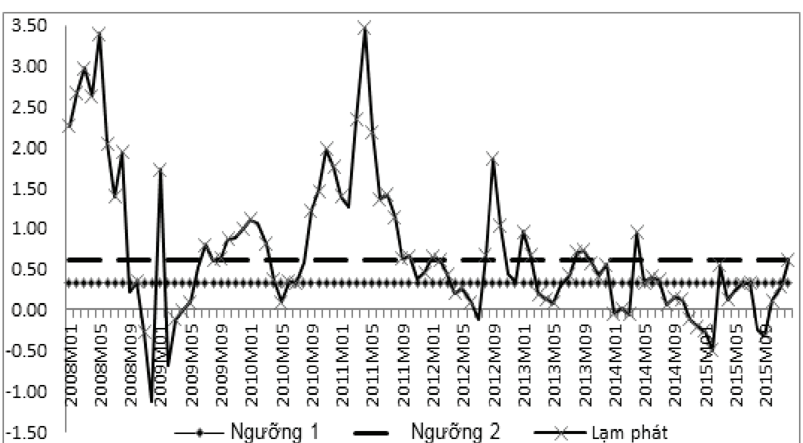
Figure 6: Accumulated response of M2 to generalized one S.D. innovation of CPI



Source: Authors' calculations.

But it even does not appear in an average inflation environment while weakly occurs in low inflation one. This finding helps to prove the hypothesis of Taylor (2000), showing the influence of inflation's environment to ERPT. In our sample period, Vietnam's inflation is often higher than 0.62% threshold level during 2008-2012 and mostly stays lower in the rest of the whole period. Thus, ERPT in Vietnam generally occurs before 2012, this supports to explain the high inflation phenomenon in this period.

Figure 7: Monthly inflation's developments and the two critical threshold values for Vietnam



Source: Authors' calculations and compilations.

4.3. Analysis of variance decomposition in inflation environments

Table 7 summarizes the results of variance decomposition analysis in inflation environments for all variables in our VAR's system. The results show that NEER does not play a decisive role in CPI fluctuations, rather than a contributing factor. Its role in CPI fluctuations is gradually increasing across inflation environments. From the 4th month, NEER decides about 10% (of the fluctuations) in a low inflation environment, about 18% in a medium one and about 7% in a high one. Although ERPT occurs the most strongly (and complete) in a high inflation environment, NEER plays the least role in this environment. This implies that, even in high inflationary period, ERPT still has much lower impact than others on inflation and the higher the inflation rate, the lower the role of ERPT in comparison with other factors that determine inflation.

5. Conclusion

In this paper, we examine ERPT's effects on inflation in Vietnam from January 2008 to December 2015, using TVAR approach. The results of this paper as follow:

First, ERPT in Vietnam is nonlinear depending on inflationary environments. The two threshold values of inflation that changes ERPT in Vietnam are 0.336% per month and 0.620% per month, or 4.032% per year and 7.44% per year. This makes a consideration of three inflation environments, including a low one (inflation rate ≤ 0.336%/month), an average one (0.336%/month <inflation rate ≤ 0.62%/month) and a high one (inflation rate> 0.62%/month).

Second, the degree of ERPT to inflation is different for each inflation environment including: (i) in a low inflation environment, ERPT is negligible with a new equilibrium level of 0.19%; (ii) in a medium one, the ERPT to inflation is not statistically significant or does not occur; (iii) in a high one, ERPT to inflation is complete at 1% after 7 months. This means that when inflation is above 0.620%/month, ERPT to inflation is complete; in contrast, below this level, ERPT to inflation does not occur or negligibly does. Hence, this result supports Taylor's (2000) view, contributing to the empirical evidence that the higher inflation is, the stronger ERPT is.

Third, exchange rate volatility does not play a decisive role, rather than a contributing factor of consumer price inflation's fluctuation in different inflation environments. From the fourth month onwards, exchange rate fluctuations explain respectively around 10%, 18% and 7% in low, medium and high inflation environment. This reflects the higher inflation is, the smaller role of ERPT on inflation volatility in correlation with other factors.

Table 7: Analysis of variance decomposition in inflation environments

	Low inflation environment					Average inflation environment					High inflation environment				
Period	S.E.	DLCPI	YGAP_D11	DLNEER	DLM2	S.E.	DLCPI	YGAP_D11	DLNEER	DLM2	S.E.	DLCPI	YGAP_D11	DLNEER	DLM2
Variance decomposition of CPI															
1	0.004	100.000	0.000	0.000	0.000	0.005	100.000	0.000	0.000	0.000	0.008	100.000	0.000	0.000	0.000
2	0.005	81.082	5.376	6.401	7.141	0.008	81.294	0.573	18.125	0.008	0.009	97.053	2.670	0.176	0.100
4	0.006	75.457	7.080	10.083	7.379	0.009	75.433	6.980	17.558	0.003	0.011	87.876	2.758	7.271	2.095
8	0.006	74.178	7.795	10.339	7.688	0.011	72.573	8.518	18.869	0.041	0.011	86.093	2.630	7.118	4.159
12	0.006	74.161	7.804	10.346	7.689	0.012	72.707	8.445	18.795	0.052	0.011	86.064	2.643	7.139	4.154
Variance decomposition of YGAP															
1	0.037	13.502	86.498	0.000	0.000	0.061	1.726	98.274	0.000	0.000	0.028	0.536	99.464	0.000	0.000
2	0.041	14.222	75.026	9.724	1.027	0.064	9.618	89.558	0.407	0.418	0.032	0.683	86.634	2.108	10.576
4	0.044	16.222	72.004	9.240	2.533	0.093	40.185	46.101	13.373	0.341	0.036	2.486	71.538	1.682	24.293
8	0.045	16.686	70.214	10.217	2.883	0.112	50.468	34.047	15.186	0.300	0.036	2.534	71.137	1.698	24.631
12	0.045	16.691	70.202	10.220	2.886	0.123	52.917	30.443	16.361	0.279	0.036	2.541	71.123	1.698	24.638
Variance decomposition of NEER															
1	0.011	0.994	4.528	94.478	0.000	0.023	73.108	0.095	26.797	0.000	0.015	3.357	0.279	96.364	0.000
2	0.012	3.847	4.899	82.424	8.830	0.026	65.376	4.329	30.293	0.002	0.016	13.258	0.233	86.486	0.022
4	0.012	7.743	5.432	76.378	10.447	0.028	59.019	11.378	29.589	0.014	0.017	15.239	0.422	75.695	8.643
8	0.013	8.721	5.998	74.873	10.407	0.029	59.383	10.707	29.890	0.020	0.017	15.112	0.669	75.368	8.851
12	0.013	8.729	5.999	74.863	10.407	0.030	58.994	11.497	29.484	0.025	0.017	15.113	0.669	75.366	8.852
Variance decomposition of M2															
1	0.011	14.944	1.267	7.375	76.414	0.003	51.434	0.906	41.606	6.055	0.017	0.671	2.075	0.537	96.717
2	0.012	14.539	1.843	23.191	60.427	0.011	44.549	15.945	38.649	0.856	0.018	0.610	7.449	1.161	90.779
4	0.013	17.068	2.024	24.009	56.899	0.020	69.247	6.543	23.915	0.294	0.019	6.372	9.154	1.717	82.757
8	0.013	17.498	2.383	23.833	56.286	0.024	69.264	7.065	23.379	0.293	0.019	7.524	8.981	1.829	81.666
12	0.013	17.503	2.384	23.833	56.279	0.025	69.003	7.828	22.877	0.291	0.019	7.531	8.986	1.830	81.653

Source: Author's calculations.

Our paper's results suggest a need for an appropriate mixed policy of both conducting exchange rate and controlling inflation in Vietnam. Firstly, as Vietnam's exchange rate regime tends to be more flexible, our economy's inflation target should be appropriately determined below 7.44% in order to limit the impact of the ERPT. It is helpful as well to use exchange rates for other objectives of monetary policy, such as supporting growth. Secondly, when the economy has high inflation, exchange rate should be stabilized to limit ERPT that contributes to a more serious inflation problem. Thirdly, exchange rates can be used as a tool to help cool down inflation (by reducing exchange rates).

In this paper, we only analyze the impacts of ERPT on inflation in each inflation environment, rather than the inflation's response under the impact of an exchange rate shock which could be large enough to change the inflation environment. Hence, the follow-up study may explore the overall impulse response function for the nonlinear model to have a better explain of shocks' shifting effects. From that, it will not only offer effective macroeconomic suggestions and recommendations based on specific economic contexts but also overcome the constraints of data sources.

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