EXCHANGE RATE PASS-THROUGH TO DOMESTIC PRICE INDICES IN THAILAND[‡‡]
การส่งผ่านอัตราแลกเปลี่ยนต่อดัชนีราคาสินค้าในประเทศไทย

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ABSTRACT

Understanding the exchange rate pass-through is an important implication for all central banks in open economies such as Thailand as it helps policy makers forecast inflation and decide how much to tighten monetary policy regarding to an inflation increasing. This paper investigates the degree of exchange rate pass-through in Thailand, using the new framework called the nonlinear autoregressive distributed lags (NARDL) introduced by Shin et al. (2013). The advantage of this model is to simultaneously accommodate asymmetry in both the long-run and short-run pass-through. The results reveal the zero pass-through to the Consumer Price Index (CPI) and Producer Price Index (PPI) in the long-run, implying that Thai Baht depreciation (or appreciation) does not affect any domestic prices in Thailand in the long-run. However, the partial pass-through to CPI and PPI exists in the short-run. Also, the results strongly confirm the asymmetric pass-through in the short-run which an appreciation of Thai Baht is passed-through more strongly than a depreciation of Thai Baht.

Keywords: Exchange rate pass-through, Monetary policy, Asymmetry

1. INTRODUCTION

The Bank of Thailand has officially adopted floating exchange rate regime and a new policy anchor 'Monetary Targeting' after the emergence of Asian financial crisis in 1997. The policy anchor has been revised again in 2000 and become an 'Inflation Targeting' from May 2000 to present.[1] Under the floating exchange rate and inflation targeting regime, Thai Baht fluctuations could significantly

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[1] The Bank of Thailand sets an inflation target of 0%-3.5% during 2005-2008, 0.5%-3.0% during 2009-2014, and 2.5%±1.5% during 2015-2017.

affect the level of domestic prices in Thailand. Therefore, the degree of exchange rate pass-through (ERPT) should be considered as one of the vital factors when conducting proper monetary policy. The ERPT relationship is the percentage change in domestic price resulting from a one percent change in the exchange rate between imported and exported countries. The degree of ERPT to prices ranges between zero (no pass-through) to one (complete pass-through), where values in this interval are referred to as incomplete or partial ERPT. The degree to which variations in ERPT to price plays an important role to the Bank of Thailand and policymakers because understanding a link between nominal exchange rate changes and price stability policy will help them effectively conduct the appropriate monetary policy and domestic inflation under circumstances of exchange rate variations. For instance, a depreciation of Thai Baht enables import input prices increase, which eventually raises domestic consumer price and inflation in Thailand; this situation makes a difficulty for importing countries like Thailand to control and attain a target of inflation.

Since many previous studies in ERPT only focus in developed countries, studies of ERPT in Thailand which inflation targeting is primary goal of its monetary policy is still limited. Particularly, literature accommodating asymmetry in both the long-run and short-run pass-through simultaneously is still scant. This paper therefore mainly investigates ERPT in Thailand during the period after the inflation targeting has been implemented. The model used in this paper follows Brun-Aguerre et al. (2013) with the extension of nonlinear autoregressive distributed lag (NARDL) framework introduced by Shin et al. (2013). The model is therefore suitable for examining the asymmetries of depreciation and appreciation impacts on domestic price. Furthermore, since much previous literature analyzes the ERPT by using various types of domestic price such as import price for a narrow notion for the pass-through, consumer price for a broad notion for the pass-through, and producer price for a capability of producers in absorbing pass-through. This paper decides to deploy the different types of domestic price index such as Consumer Price Index (CPI), Core Consumer Price Index (CCPI), Producer Price Index (PPI), and Import Price Index (IPI) as dependent variables to assess the extent to which exchange rate changes affect Thailand's domestic prices. This paper therefore contributes by adopting new model in capturing ERPT in Thailand and comparing the various degree of pass-through to domestic price indices in Thailand.

Our main results basically confirm an existence of long-run relationship for Thailand's domestic prices (CPI and PPI) and explanatory variables. The results unfold the zero pass-through to the CPI and PPI in the long-run, implying that Thai Baht depreciation (or appreciation) does not directly affect any domestic price in Thailand. However, the partial pass-through to the CPI and PPI exists only in the short-run. When the asymmetric pass-through is investigated, the results strongly confirm the asymmetric pass-through in the short-run which Thai Baht appreciation are passed-through more strongly than Thai Baht depreciation. Our results therefore have important implications for the Bank of Thailand in conducting monetary policy under inflation targeting regime. In the presence of Thai

Baht deprecation, the smaller the interest rate adjustment is required in maintaining the inflation target according to the zero degree of ERPT in the long-run. However, policy makers should concern more about the partial pass-through to CPI and PPI in the short-run and have different monetary policy reaction in response to Thai Baht depreciation or appreciation according to an existence of the asymmetric pass-through in the short-run.

The paper is organized as follows. Section 2 addresses recent findings in the literature regarding of the association between ERPT and inflation targeting, including the assumption of asymmetric pass-through. The data and model specification are presented in section 3 and 4, respectively. The empirical findings are shown in section 5. Section 6 concludes and draws out the policy implications.

2. LITERATURE REVIEW

An investigation of the ERPT with respect to the inflationary environment has been analyzed and the model has been progressively developed over a number of years in many developed countries. On one hand, explanatory variables in the ERPT model are particularly modelled by the pricing behavior of import prices or markup model.[2] Campa and Goldberg (2005) then include the real output as the best proxy of importing country's demand conditions together with exporter's marginal cost and exchange rate to explain the degree of ERPT. Choudhri and Hakura (2006) discuss the theoretical ERPT model based on the new open-economy macroeconomic models, which the foreign CPI and exchange rate are used as the explanatory variables for ERPT model. Delatte and Lopez-Villavicencio (2012) assume that the unit labor costs, energy prices, and exchange rate are able to explain the change in domestic price level. Recently, Brun-Aguerre et al. (2013) use export price index as well as the exchange rate as independent variables to explain the domestic price behavior. On the other hand, dependent variables in ERPT model are also widely discussed. Using either import prices or consumer prices is another crucial issue to represent the domestic price level. The import prices which are prices calculated from only import goods observed at the dock are the narrowest notion of pass-through to the price of goods.[3] Meanwhile, consumer prices represent domestic consumer baskets which are broader definition and widely employed in the pass-through literature.[4]

Previous literature such as Eichengreen (2002), Schmidt-Hebbel and Werner (2002), and Edwards (2006) discussed a relationship between a decline in ERPT and introduction of inflation targeting as a consequence of a credibility of central bank after adoption of IT. Flamini (2007) analyses the

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[2] See, Krugman (1987) for more details.

[3] The ERPT to import prices will represent the price behavior of foreign firms but may not have a strong association with the domestic inflationary environment. See, for example, Ihrig et al. (2006) and Sekine (2006).

[4] See, for example, Choudhri and Hakura (2006) and Delatte and Lopez-Villavicencio (2012).

relation between ERPT and inflation targeting for a small open-economy and finds the ability in identifying the degree of pass-through of the central bank in stabilizing in the short run CPI inflation. Mishkin (2008) also confirms a strong presence of nominal anchor leading to less depreciation pass-through to consumer price in country with low and stable inflation. Nogueira Junior (2007) analyses an ERPT before and after adoption of inflation targeting, estimating by the autoregressive distributed lag (ARDL) method. The empirical results in five emerging countries and three developed countries are consistent with Edwards (2006) that there is strong evidence of decline in ERPT after IT adoption for all countries regardless using any price indices-consumer or producer-in estimation. Prasertnukul et al. (2010) also use the ARDL approach in estimating a relationship among exchange rates, price levels, and inflation targeting in Asian economies. A dummy variable for a period of inflation targeting is added into their model. The results show strong evidence of a statistically significant relationship between a decline in ERPT and the adoption of inflation targeting in South Korea and Thailand whereas the results are less clear for Indonesia and the Philippines. Taguchi and Sohn (2010) examine the ERPT by the GMM method of four East Asian countries. According to their results of a decline in pass-through after the adoption of inflation targeting, the reaction of domestic agents is also investigated and revealed that domestic agents are likely to change prices in response to an exchange rate shock under a strong nominal anchor toward price stability. Meanwhile, Coulibaly and Kempf (2010) use a panel VAR to examine the impact of inflation targeting on ERPT of 15 countries conducting inflation targeting and 12 countries conducting non-inflation targeting. There is strong evidence of a decline in pass-through to all price indices (import prices, producer prices, and consumer prices) for countries conducting inflation targeting. All above empirical results confirm a decline in ERPT after the adoption of IT which contributes to an inflation stability and central bank credibility. In a related study Reyes (2007) examines ERPT to inflation targeting in six emerging economies in which implement this regime due to a 'fear of floating'. The results suggest that a declining pass-through effect in emerging markets can be explained by a switch in monetary policy regimes from crawling peg to inflation targeting. His emerging economies findings confirm that the adoption of IT causes the lower degree of pass-through. The decoupling of exchange rates from domestic prices is seen to be a result of direct or indirect interventions of the central bank in the foreign exchange market in order to achieve their inflation target. This is consistent with Pavasuthipaisit (2010) who studies the responsiveness of inflation-targeting central banks to exchange rate movements. His results reveal that central banks should pay more attention to nominal exchange rate movements when the countries experience complete pass-through. By contrast, central banks have less concern on exchange rate fluctuations and rather focus on inflation and monetary growth when ERPT is very small. Nogueira Jumior (2006) suggests that central banks may choose to intervene the foreign exchange market by smoothing short-run exchange rate movements

in order to attain their target of inflation. This finding can be inferred as fear of inflation rather than fear of floating.

However, most ERPT literature discussed earlier tests a symmetric relationship between the exchange rate and price level. This implies that appreciation and depreciation of currencies have an effect of the same direction (sign effect) as well as proportionally magnitude (size effect). This assumption is not ideal. One explanation for this difference is price rigidities: Prices tend to be stickier downwards than they are upwards and thus the higher degree of price rigidity the smaller the pass-through. Other explanations for asymmetry include capacity constraints theory, market share theory, and technology switching theory. According to the capacity constraints theory, the ERPT is higher when exporting countries' currency depreciates since exporters cannot accommodate an excess demand from the depreciation of exporting countries' currency due to the limitation of full capacity. Under the market share theory, exporters tend to decrease their mark-ups when competition is high and their own currency appreciates in order to maintain their market share while they tend to keep their mark-ups unchanged when their own currency depreciates. Finally, technology switching theory suggests that exporters are likely to change a source of cheaper production or use local inputs when domestic currency depreciates, which causes their importing input costs more expensive. Hence, there are many explanations regarding an asymmetric response of consumer price. When asymmetric effects of exchange rates on prices are neglected, these may seriously distort the proper conduct of monetary policy. Recent empirical studies in a relationship between asymmetric ERPT and monetary policy however are still relatively scarce.

In the first stage of investigating an asymmetric ERPT, adding dummy variables for asymmetry as explanatory variables into the model is a simple way to measure the asymmetric ERPT.[5] However, Webber (2000) argues that dummy variables are restricted an analysis to a particular time frame that contains continuous appreciation or depreciation series so the exchange rates should be decomposed into the series of accumulated sum of the appreciation and depreciation for analysis. The latest research in this area uses the nonlinear autoregressive distributed lags (NARDL) model proposed by Shin et al. (2013) which permits estimation of asymmetric long run as well as short run pass-through at the same time. For example, Delatte and Lopez-Villavicencio (2012) investigate the response of consumer price to exchange rate shocks in a framework that accommodates asymmetry both in the long-run equilibrium relationship and in the short-run dynamics in four advanced economies. Their model is based on a mark-up model. The results show that prices react differently to appreciation and depreciation over the long-run. They also show that depreciation pass-through to prices more than appreciation regarding to weak competition structures in international trade. Brun-Aguerre et al. (2013) explore possible asymmetries in the reaction of import price to changes

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[5] See, for example, Pollard and Coughlin (2004) and Bussiere (2007)

in the exchange rate in 33 economies, of which 19 are developed and 14 emerging. Analysing by time series as well as panel estimation, they find that depreciation results in more pass-through than appreciation in the long-run.[6] This indicates downward rigidity of import prices and can be inferred that pass-through strongly affects inflation of importing countries. This confirms the results of Delatte and Lopez-Villavicencio (2012) albeit using the different price indices. Finally, El bejaoui (2013) also implement the NARDL model, examining both import and export price pass-through for four developed economies. The results however suggest that the appreciation yields stronger pass-through to export and import prices than depreciation. Even though all above ERPT findings mainly contribute to asymmetric ERPT which mostly explains price behaviour of foreign firms according to imperfect competition or market power, they incompletely mention the ERPT regarding to monetary policy decision.

3. DATA

This paper investigates ERPT in Thailand where the inflation targeting has been implemented since May 2000. However, the dataset covers from January 2007 to December 2017 since the structural changed period has been avoided inflation. Data are monthly data. The domestic prices (y) used in this paper are Consumer Price Index (CPI), Core Consumer Price Index (CCPI), Producer Price Index (PPI), and Import Price Index (IPI). The explanatory variables facilitating an estimation are the nominal effective exchange rate index of the foreign currency against the domestic currency and the Export Price Index (y^*). The nominal effective exchange rate index (ER) is transformed to the Thai Baht against a basket of foreign (exporter's) currency, implying that an increase of index indicates a depreciation of the domestic currency. The Export Price Index (y^*) measures the Thailand's export price of goods and services to other countries, implying the country's competitiveness of international trade.

4. METHODOLOGY

To measure the degree of ERPT in Thailand, this paper adopts the ERPT model from Brun-Aguerre et al. (2013). Brun-Aguerre et al. (2013) accommodate the exchange rate asymmetry by decomposing the nominal effective exchange rate (ER) into

$$ER_t \equiv ER_0 + ER_t^+ + ER_t^- \tag{1}$$

where $ER_{i,0}$ is an arbitrary initial value[7] and

$$ER_t^+ = \sum_{j=1}^{t} \Delta ER_{i,t}^+ = \sum_{j=1}^{t} \max\left(\Delta ER_j, 0\right) \text{ and } ER_t^- = \sum_{j=1}^{t} \Delta ER_t^- = \sum_{j=1}^{t} \min\left(\Delta ER_j, 0\right) \tag{2}$$

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[6] The evidence of asymmetric pass-through in the short-run shows approximately 30 percent of countries in the sample, compared to more than half of countries experiencing long-run asymmetric pass-through.

[7] The initial value $e_{i,0}$ can be set to zero without loss of generality.

which are partial sum process of positive and negative exchange rate changes, thereby ER_t^+ and ER_t^- captures periods of Thai Baht depreciation and periods of Thai Baht appreciation, respectively. Thus, the cointegrating long-run equilibrium ERPT with a decomposition of exchange rate index as follows:

$$y_{i,t} = \beta_i^+ ER_t^+ + \beta_i^- ER_t^- + \lambda_i y_t^* + u_{i,t} \tag{3}$$

where $y_{i,t}$ is a Thailand's domestic price index such as Consumer Price Index (CPI), Core Consumer Price Index (CCPI), Producer Price Index (PPI), and Import Price Index (IPI). y_t^* represents the Thailand's export price index. β_i^+, β_i^-, and λ_i is a vector of unknown long-run coefficients and $u_{i,t}$ follows i.i.d process with zero means and finite variances. The error correction term is substitute into the NARDL framework introduced by Shin et al. (2013). Therefore, the NARDL(p,q,r) for investigating the asymmetric ERPT to domestic price are yielded as follows

$$\Delta y_{i,t} = \alpha_i + \rho_i y_{i,t-1} + \pi_i^+ ER_{t-1}^+ + \pi_i^- ER_{t-1}^- + \gamma_i y_{t-1}^* + \sum_{j=1}^{p-1} \omega_{i,j} \Delta y_{i,t-j}$$
$$+ \sum_{j=0}^{q-1} \left(\theta_{i,j}^+ \Delta ER_{t-j}^+ + \theta_{i,j}^- \Delta ER_{t-j}^- \right) + \sum_{j=0}^{r-1} \delta_{i,j} \Delta y_{t-j}^* + \varepsilon_{i,t} \tag{4}$$

where the Δ denotes the (log) price differences. The $\frac{-\pi_i^+}{\rho_i}$ (or β_i^+) and $\frac{-\pi_i^-}{\rho_i}$ (or β_i^-) denote coefficients of positive and negative long-run pass-through to domestic price for Thailand, respectively. The $\frac{-\gamma_i}{\rho_i}$ (or λ_i) represents the long-run relationship between domestic price and export price. The lag structure p, q, and r, in Eq. (4) is denoted to 2 since Marrazi et al. (2005) and Seikine (2006) discover that pass-through tends to occur rapidly. Then, coefficients of short-run pass-through are explained by the contemporaneous ($\theta_{i,0}^+$ and $\theta_{i,0}^-$) and one-quarter lag ($\theta_{i,1}^+$ and $\theta_{i,1}^-$). The summation of the contemporaneous pass-through in the same period of exchange rate shock and one quarter lag after the exchange rate shock is considered for the short-run pass-through. Eq. (4) therefore accommodates asymmetry in both the short- and long-run asymmetric pass-through to consumer price under the NARDL framework.

To assess the significance of the long-run relationship, the BDM test (tBDM) of Banerjee et al. (1998) and the PSS test (fPSS) of Persaran et al. (1996) and Pesaran et al. (2001) are tested. These bound tests (tBDM and fPSS) give reliable inference in the presence of a mixture of I(0) and I(1) variables. In the case of the BDM test, the null hypothesis is that ρ_i equals zero in (4). The fPSS is on the joint null hypothesis that the coefficients are jointly equal to zero, $\rho_i = \beta_i^+ = \beta_i^- = \lambda_i = 0$. In both tests, the null hypothesis therefore indicates the absence of a long-run relationship.

From Eq. (4) standard Wald test statistics are used to test the null hypothesis of symmetric pass-through in the long-run and short-run. Specifically, the null hypothesis of long-run symmetry is $\beta_i^+ = \beta_i^-$ against the alternative of long-run asymmetry which is $\beta_i^+ \neq \beta_i^-$. In the short-run ERPT, the summation of ERPT in the same quarter and one quarter after the exchange rate shocks is

considered. The null hypothesis of short-run symmetry is $\sum_{j=0}^{q-1} \theta_i^+ = \sum_{j=0}^{q-1} \theta_i^-$ against the alternative which is $\sum_{j=0}^{q-1} \theta_i^+ \neq \sum_{j=0}^{q-1} \theta_i^-$.

5. EMPIRICAL RESULTS

The summary statistics of domestic price indices, exchange rate, and export price index are provided in Table 1. After implementation of inflation targeting, the average monthly inflation rate in Thailand calculating from CPI is 0.0683% for the past 11 years. The Jarque-Bera test confirms all data series matching a normal distribution.

Table 1 Descriptive Statistics

	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Jarque-Bera
1st Difference							
ΔCPI	0.0683%	0.9694%	-1.2951%	0.2357%	-1.2576	13.0506	585.9040***
ΔCCPI	0.0450%	0.3785%	-0.4251%	0.0797%	-0.6241	15.2929	833.3438***
ΔPPI	0.0752%	1.9262%	-2.9310%	0.6182%	-0.5907	7.7345	129.9695***
ΔIPI	0.0490%	2.3904%	-1.8864%	0.6138%	0.3277	4.4646	14.0534***
ΔER	-0.0010%	0.0649%	-0.0662%	0.0170%	0.2164	6.9119	84.5507***
ΔER+	0.0054%	0.0649%	0.0000%	0.0107%	3.1645	14.8151	980.5978***
ΔER-	-0.0063%	0.0000%	-0.0662%	0.0103%	-3.0224	14.5903	932.6810***
Δy*	0.0624%	2.0446%	-1.3267%	0.5575%	0.4724	4.0214	10.5656***

Notes: ΔCPI is the change in Consumer Price Index, ΔCCPI is the change in Core Consumer Price Index, ΔPPI is the change in Producer Price Index, ΔIPI is the change in Import Price. ΔER is the changes in nominal effective exchange rate index defined as a Thai Baht against a basket of foreign currency. ΔER+ is the cumulative of positive changes in Thai Baht or the period of Thai Baht depreciation. ΔER- is the cumulative of negative changes in Thai Baht or the period of Thai Baht appreciation. Δy* is the log difference in Thailand's export price index, implying Thailand's competitiveness of international trade. *, **, and *** denote the rejection of the null at 10%, 5%, and 1% level, respectively.

Table 2 presents the unit root test with the ADF and the NG-Perron. The null hypothesis for the ADF test and NG-Perron is that series contains a unit root. The values in Table 2 indicate that all series in log level contain one unit root and become stationary when the first difference is performed.

Table 2 Unit Root Testing

	ADF		NG-PERRON	
	Log Level	1st Difference	Log Level	1st Difference
CPI	0.4697	0.0000	-5.7177	-50.9946***
CCPI	0.7491	0.0000	-7.8505	-56.6847***
PPI	0.2824	0.0000	-5.8344	-52.7256***
IPI	0.0821	0.0000	-12.6869	-53.4571***
ER	0.2493	0.0000	-12.8634	-3.67015
ER+	0.3198	0.0000	-0.88251	-64.3482***
ER-	0.0153	0.0000	-1.85454	-7.24819
y*	0.0195	0.0000	-25.3412***	-59.2754***

Notes: The Augmented Dickey-Fuller (ADF) test and the NG-Perron test include both a constant and a linear time trend. Lags are chosen based on Schwarz Information Criterion (SIC). The ADF values in the table present the probability. The NG-Perron values in the table present the test statistics. *, **, and *** denote the rejection of the null at 10%, 5%, and 1% level, respectively.

Even though the NG-Perron values indicate a mixture of series with unit root and stationary, the model in Eq. (4) can accommodate a mixture of I(0) and I(1) series according to the power of the NARDL specification. The bound testing procedure of the tBDM and the fPSS shown in Table 3 is used to test a conintegration in Eq. (4). Though the tBDM does not reject the null hypothesis for all series, the fPSS statistic mostly rejects the null hypothesis of an absence of long-run relationship. As we do not reject the null hypothesis of an absence of long-run relationship for CCPI, we conjecture that CCPI excludes energy and food prices that can have temporary price shocks, which the monetary policy makers have no control. Also, we could not find the long-run relationship between IPI and export price index (y_t^*).

Table 3 Cointegration Testing

	tBDM	fPSS
	T-statistic	F-statistic
ΔCPI	-1.5081	5.6739**
ΔCCPI	-0.6691	2.9349
ΔPPI	-2.4313	5.3658**
ΔIPI	-1.8436	3.4837

Notes: The critical values tabulated for the tBDM and the fPSS are different from the conventional t and f statistics. The critical values for the tBDM and the fPSS are tabulated by Pesaran et al. (2001). The critical value of tBDM at 1%, 5%, and 10% level is -4.10, -3.53, -3.21, respectively. The critical value of fPSS at 1%, 5%, and 10% level is 6.36, 4.85, 4.10, respectively. *, **, and *** denote the rejection of the null at 10%, 5%, and 1% level, respectively.

Since we only confirm the long-run relationship for the CPI and PPI, only these 2 dependent variables are used as the Thailand's domestic price index (y_i) for ERPT estimation. The CPI and PPI are separately estimated in Eq. (4). Table 4 reports the asymmetric pass-through estimation for Thailand using the Eq. (4) with lag structure p = q = r = 2. The asymmetric long-run relationship is tested for the null hypothesis of zero pass-through (β_i^+ = 0 or β_i^- = 0). The cumulative short-run relationship also tested for the hypothesis of zero pass-through ($\sum \theta_{i,}^+$ = 0 or $\sum \theta_{i,}^-$ = 0). The results reveal as follows; First, we do not reject the null of zero pass-through in the long-run when the CPI is used as the domestic price index (y_i) to estimate the ERPT in Thailand, implying that Thai Baht depreciation (or appreciation) does not affect the domestic price level measuring by CPI in Thailand. However, the null hypothesis of zero pass-through in the short-run is rejected at 5% significance level, indicating that the ERPT to the CPI exists in the short-run. Second, the result of ERPT to the PPI is consistent with the case of CPI.

Table 4 Asymmetric Pass-through Estimation

	ΔCPI	ΔPPI
α_i	0.2180***	0.4147***
	(0.0717)	(0.1533)
ρ_i	-0.0309	-0.0513**
	(0.0205)	(0.0211)
π_i^+	0.6157	1.5800
	(1.1051)	(2.8435)
π_i^-	-0.5687	-0.4432
	(0.6846)	(1.8272)
γ_i	-0.0838***	-0.1648**
	(0.0302)	(0.0762)
ω_i	0.2731***	0.3605***
	(0.0871)	(0.0808)
$\theta_{i,t}^+$	-5.3793**	-12.7542**
	(2.1904)	(5.4973)
$\theta_{i,t-1}^+$	-2.7133	-4.6170
	(2.0651)	(5.2038)
$\theta_{i,t}^-$	8.6853***	20.7172***
	(2.4054)	(5.9894)

$\theta^-_{i,t-1}$	-0.4766	3.7730
	(2.3679)	(5.7114)
$\delta_{i,t}$	-0.0003	0.1170
	(0.0422)	(0.1061)
$\delta_{i,t-1}$	0.0868**	0.1252
	(0.0425)	(0.1096)
Adj R-square	30.52%	35.89%
Long-run and Short-run pass-through	ΔCPI	ΔPPI
λ_i	-2.7109	-3.2134*
	(1.9301)	(1.8330)
β^+_i	19.9149	30.8011
	(33.6798)	(51.8405)
β^-_i	-18.3942	-8.6395
	(25.4930)	(36.9816)
$\sum \theta^+_{i,}$	-8.0927***	-17.3712**
	(3.0275)	(7.5446)
$\sum \theta^-_{i,}$	8.2087**	24.4902***
	(3.4889)	(8.4670)

Notes: All parameters are obtained from Eq. (4) estimated by the OLS method. λ_i represents the speed of adjustment calculating from $\frac{-\gamma_i}{\rho_i}$. β^+_i represents the long-run pass-through depreciation calculating from $\frac{-\pi^+_i}{\rho_i}$. β^-_i represents the long-run pass-through appreciation calculating from $\frac{-\pi^-_i}{\rho_i}$. $\sum \theta^+_{i,}$ represents cumulative short-run depreciation and $\sum \theta^-_{i,}$ represents cumulative short-run appreciation. Standard errors are shown in parentheses. *, **, and *** also denote the rejection of the null at 10%, 5%, and 1% level, respectively.

The Wald test in Table 5 is used to confirm whether asymmetric pass-through in Thailand exists or not. The results indicate that the null hypothesis of symmetric pass-through is rejected in the long-run at 10% significance level, indicating the long-run asymmetric pass-through is captured in both CPI and PPI model. Interestingly, the short-run symmetric pass-through is strongly rejected at 1% significance level for both models. The null hypothesis of cumulative short-run symmetric pass-through is also rejected at 1% significance level for both cases. The results in Table 5 are in line with the coefficients of short-run pass-through in Table 4, indicating that an appreciation of Thai Baht is passed-through more strongly than a depreciation of Thai Baht. This is consistent with El bejaoui (2013) who found that an appreciation is passed through prices more than a depreciation in developed countries. However, our results contradict to previous paper such as Delatte and Lopez-Villavicencio (2012) or Brun-Aguerre et al. (2013) that a depreciation yields stronger pass-through to prices than an appreciation in many developed countries. We therefore conclude that an asymmetric pass-through in Thailand strongly exists in the short-run.

Table 5 Asymmetric Pass-through Estimation

Wald test	ΔCPI	ΔPPI
Long-run symmetry	38.3091*	39.4405*
Short-run symmetry	-14.0646***	-33.4714***
Cumulative short-run symmetry	-16.3014***	-41.8614***

Notes: *, **, and *** also denote the rejection of the null at 10%, 5%, and 1% level, respectively.

6.   CONCLUSION AND POLICY IMPLICATIONS

Understanding the behavior of ERPT is important implications for the central bank in conducting monetary policy, particularly, country under inflation targeting regime like Thailand. This paper aims to examine the ERPT in Thailand during the period after the inflation targeting has been implemented. The dataset covers the periods of January 2007 - December 2017. The ERPT model in this paper follows Brun-Aguerre et al. (2013) with the extension of nonlinear autoregressive distributed lag (NARDL) framework introduced by Shin et al. (2013). This paper applies the various domestic price indices such as CPI, CCPI, PPI, and IPI as dependent variables to assess the extent to which exchange rate changes affect Thailand's domestic prices. This paper therefore contributes in two aspects. First, a new model in capturing ERPT in Thailand is adopted. Second, the power of Thailand's domestic price index in measuring the degree of pass-through is compared. The results reveal the zero pass-through to the CPI and PPI in the long-run, implying that, Thai Baht depreciation (or appreciation) does not affect any domestic price in Thailand in the long-run. However, the partial pass-through to the CPI and PPI exists in the short-run. When the asymmetric pass-through is investigated, the results strongly confirm the asymmetric pass-through in the short-run which Thai Baht appreciation is passed-through more strongly than Thai Baht depreciation. However, the long-run asymmetric pass-through is still captured at lower level. Our results therefore have important implications for Bank of Thailand in conducting monetary policy under inflation targeting regime in many aspects. First, in the presence of Thai Baht deprecation, the Bank of Thailand has less likely constrained to adjust the interest rate in maintaining the inflation target according to the zero degree of ERPT in the long-run. Second, policy makers should monitor the consumer prices and producer prices since we capture the partial pass-through to the CPI and PPI but not to IPI or CCPI, implying that the prices are marked up by producers regarding to Thai Baht depreciation. Finally, policy makers should have different monetary policy reaction in response to Thai Baht depreciation or appreciation according to an existence of the asymmetric pass-through in the short-run.

7.   REFERENCES

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