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Product Quality and Asymmetric Exchange Rate Pass-Through in the Iron and Steel Industry between Thailand and Vietnam

Santi Termprasertsakul [1] and Jakkrich Jearviriyaboonya [2]

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ABSTRACT

This paper studies the impact of product quality on the degree of exchange rate pass-through (ERPT) by investigating 19 products at the HS 4-digit level in the iron and steel industry, mostly traded between Thailand and Vietnam. Vertical product differentiation is applied to measure the heterogeneous quality of iron and steel traded between Thailand and Vietnam. The monthly data for 2010-2019 period are used in the analysis. Furthermore, this study employs a Nonlinear Autoregressive Distributed Lag (NARDL) model to examine the asymmetric behavior of exchange rate pass through with heterogeneous level of product quality. The empirical results reveal a complete pass-through in the long run and an incomplete pass-through in the short run. The product quality affects the degree of ERPT through to import prices. In addition, the asymmetry of ERPT is captured in the long run as well as the short run.

Keywords: exchange rate pass-through; vertical product differentiation; nonlinear autoregressive distributed lags

Introduction

The relationship between exchange rate movement and import price is a key research area in international economics since the degree of exchange rate pass-through (ERPT) in relation to import prices is used by the central bank as an indicator for measuring price competitiveness when conducting monetary policy. Fundamentally, the degree of ERPT in relation to import

[1] Assistant Professor, Faculty of Business Administration for Society, Srinakharinwirot University
E-mail: santit@g.swu.ac.th
[2] Corresponding Author, Assistant Professor, Faculty of Economics, Khon Kaen University
E-mail: Jakkrichjear@hotmail.com

prices ranges between zero (zero pass-through) to one (complete pass-through). Meanwhile, values between zero and one are referred to as incomplete pass-through. The degree of ERPT to import prices depends on several factors such as market structure (Dornbusch, 1987), frequency of price adjustment (Gopinath and Itskhoki, 2010), or degree of product differentiation (Yang, 1997; Auer and Chaney, 2009; Hu et al., 2015). Yang (1997), Bacchetta and Wincoop (2005), Bussiere and Peltonen (2014), Bernini and Tomasi (2015), and Hu et al. (2015) demonstrate that ERPT varies with the quality (or differentiation) of products. Particularly, products with relatively high unit values have a higher degree of ERPT. In other words, the more differentiated the product, the greater the market power, and therefore, the higher the degree of ERPT. Although much previous literature investigates the ERPT to import prices in Thailand (Toh and Ho, 2001; Pholphirul, 2003; Ghosh and Rajan, 2009; Byrne et al., 2010), no studies mention the impact of product quality on ERPT to import prices in Thailand.

Table 1 Top five countries from which Thailand imported steel in 2018

No	HRC and CRC	Billet and Slab	Steel Bars, Section and Wire Rods	Scrap, Iron Ore and Ingot	Coated Steel
1	Japan (59%)	Iran (40%)	China (47%)	USA (23%)	China (47%)
2	China (17%)	Japan (15%)	Japan (28%)	Russia (10%)	Japan (22%)
3	Korea (13%)	Russia (14%)	Korea (7%)	Myanmar (8%)	Vietnam (19%)
4	Taiwan (3%)	India (5%)	Taiwan (5%)	India (8%)	Taiwan (8%)
5	Vietnam (2%)	UAE (5%)	Vietnam (5%)	China (3%)	Malaysia (1%)

Source: Trade map, compiled by Krungsri Research

Table 2 Thailand's top five export markets in 2018

No	Steel Bars, section and Wire Rods	Scrap, Iron Ore and Ingot	Pipes	HRC and CRC	Structure and Parts
1	Japan (19%)	Philippines (21%)	USA (49%)	USA (23%)	Japan (43%)
2	Vietnam (16%)	India (19%)	Australia (5%)	Malaysia (3%)	USA (8%)
3	Lao PDR (8%)	Indonesia (12%)	Myanmar (5%)	Vietnam (10%)	New Zealand (6%)
4	China (6%)	Bangladesh (10%)	Cambodia (4%)	Lao PDR (6%)	Lao PDR (5%)
5	India (4%)	Korea (10%)	Malaysia (4%)	Italy (5%)	Oman (4%)

Source: Trade map, compiled by Krungsri Research

In addition, nowadays, the value of exports and imports between Thailand and Vietnam is of interest since Vietnam is one of the major destinations for both Thai exporters and importers. Vietnam was the fourth largest market destination for Thai exporters from 2017–2019. Exports to Vietnam grew by about 19% in 2017 and have continued to rise at the rate of approximately 5% per year. Meanwhile, the value of imports from Vietnam equated to about 9% in 2017 and has been increasing by about 3% per year. According to the statistics report of the General Department of Vietnam Customs, Vietnam's exports of iron and steel have increased to nearly 2.5 billion USD, and Thailand is one of the six key market destinations. Table 1 shows that the imports of coated steel ranked third among other countries whereas hot-rolled coil (HRC), cold- rolled coil (CRC), steel bars, and section and wired rods ranked fifth. Table 2 shows that Vietnam is the second largest market destination for steel bars and section and wired rods, exported from Thailand. The export of HRC and CRC from Thailand to Vietnam ranked third among five countries. In tables 1 and 2 depict the importance of recent trade in the iron and steel industry between Thailand and Vietnam.

Thus since Thailand and Vietnam are the main trading partners for iron and steel products in the AEC (ASEAN Economic Community), this paper aims to investigate the relationship between the exchange rate movement and import price; the so-called ERPT to import price, focusing on the ERPT for each of the 19 products at the HS 4-digit level by including the impact of product differentiation on ERPT. This paper also examines the exchange rate asymmetry that could directly affect the import price. The Nonlinear Autoregressive Distributed Lag model (NARDL) introduced by Shin et al. (2014) is used to measure the long-run relationship among variables and the impact of short-run and long-run exchange rate asymmetry. The remainder of the paper is organized as follows. Section2 reviews the literature on ERPT. The data and methodology are presentment in Section 3 and section 4 respectively. Section 5 present empirical results and the last section conclude and propose policy implications.

Literature Review

The issue of ERPT with respect to trade prices is an important field of investigation since it is an important parameter for price competitiveness and the implementation of monetary policy. The ERPT ranges from zero (no pass-through) to one (complete pass-through). Complete pass-through refers to a situation where a depreciation in home currency will lead to an increase in import price. On the other hand, when the degree of ERPT equals zero, this infers that a depreciation in home currency will not increase the import price. This situation is defined as zero pass-through. Meanwhile, an incomplete pass-through is identified (the value of ERPT is between zero and one) if the exchange rate movement partially affects the import price. Previous studies (Yang, 1997; Bussiere and Peltonen, 2014; Brun-Aguerre et al., 2017; Hu et al., 2015) provide evidence of incomplete pass-through, whereby import prices do not fully impact on changes in the exchange rate and when the degree of ERPT varies across industries. Pholphirul (2003) studied the ERPT in Thailand and confirmed the existence of an incomplete pass-through in many industries, such as those involved in the production of animal and vegetable oils and fats, and machinery. Toh and Ho (2001) investigated the ERPT in selected ASIAN countries, including Thailand. Their results show a complete pass-through at aggregate and industry level, implying that Thailand has low market power and encounters intense competition in exporting industries. Ghosh and Rajan (2009) studied the ERPT in Thailand and Korea at the aggregate level. The ERPT to import price in both countries is explicitly higher than the ERPT to consumer price index (CPI). The macroeconomic determinants of ERPT such as trade openness, financial crises, and monetary policy are also examined.

Previous empirical research also reveals the determinants of ERPT to import price at micro-level. For example, Dornbusch (1987) states that the degree of ERPT to import price depends on product substitutability and market structure, while Gopinath and Itskhoki (2010) found that the degree of ERPT varies with the frequency of price adjustment. The results confirm the existence of a positive relationship between the frequency of price adjustment and ERPT, suggesting that firms which infrequently adjust prices have lower degree of ERPT. Many recent research studies focus on product differentiation as a function of the ERPT. Yang (1997) investigated the ERPT in the US manufacturing industry and its determinants. The results reveal a positive relationship between the ERPT and the degree of VPD, and a negative relationship between ERPT and marginal cost. Since exporters sell products of different quality to customers with heterogeneous preferences,Bacchetta and Wincoop (2005) theoretically found that the more differentiated the product, the more likely the exporter will price it in their own country's currency. Bussiere and Peltonen (2014) examined the ERPT to import price as well as the export price in 41 countries, including Thailand. The empirical results reveal substantial heterogeneity across countries and an incomplete ERPT in Thailand, which is also determined by microeconomic factors such as product differentiation. However, Bernini and Tomasi (2015) empirically measure the ERPT of Italian firms, whereby the product quality is set as a dummy variable and interacts with changes in exchange rates. Chen and Juvenal (2016) also measure the interaction between product quality (according to product ratings) and the exchange rate, revealing a negative coefficient as expected. The results, therefore, confirm that high-quality products are less sensitive to exchange rate movement or the degree of pass-through decreases with quality. Hu et al. (2015) investigated the impact of vertical product differentiation on ERPT in China, using the pricing behavior of HS 8-digit products and 1578 product observations across industries. The results confirm that a positive relationship exists between the ERPT and VPD.

However, most of the previously mentioned papers investigate the symmetric relationship between ERPT and VPD. Some recent studies document the asymmetry and nonlinearity of the relationship. Byrne et al. (2010) investigated the degree of ERPT to import prices for a panel of 14 emerging economies, including Thailand, using the interaction between the dummy variable and the exchange rate during periods of appreciation/depreciation. The results reveal strong evidence of asymmetric pass-through in Asian and Latin American countries. Hu et al. (2015) not only examined the impact of VPD on ERPT but also investigated the asymmetry of ERPT. The dummy variables of yen depreciation and appreciation are set to capture the asymmetric effect.

The results confirm that the asymmetry between ERPT and yen depreciation is lower than for yen appreciation. Some recent research papers have measured the asymmetry of ERPT using the Nonlinear Autoregressive Distributed Lags (NARDL) proposed by Shin et al. (2014). This methodology accommodates both short-run and long-run asymmetric estimation. For example, Brun-Aguerre et al. (2017) concluded that the capacity constraints theory, market share theory, and technology switching are influential factors in asymmetric pass-through. Their study aimed to measure the asymmetric response of import prices to exchange rate changes in 33 countries, including Thailand. The results confirm the asymmetry of ERPT, in that the pass-through of depreciation is stronger than the pass-through of appreciation in the long run. Subsequently, Luckstead (2018) studied the asymmetry between ERPT and import prices at the product level, using cocoa beans from Côte D'Ivoire, Ghana, and the Dominican Republic. The results present substantial heterogeneity in ERPT across countries and the NARDL confirms substantial asymmetry in the response of cocoa trade volume to exchange rate volatility. Depreciation in the US dollar tends to lead to a decrease in US imports, while US dollar appreciation may not lead to an increase in US imports. This implies that the quality of imported cocoa is relatively low, with US cocoa importers searching for other sources. Meanwhile, US cocoa importers tend to purchase more from countries during the depreciation and appreciation of the US dollar, implying good quality cocoa.

Data

The import price index, consumer price index, and producer price index from January 2010– December 2019 are used to calculate the degree of exchange rate pass-through. To calculate the VPD, the unit value of imported product i from Vietnam is divided by the unit value of exported product i to Vietnam. This follows Hu et al. (2015) that applied in Eq. (1)

$$VPD_i = \frac{\text{Price of product i imported from Vietnam}}{\text{Price of product i exported to Vietnam}} \tag{1}$$

In this case, the unit value of product is used as a proxy of the quality of product, i.e., this represents the price-quality relationship based on the placebo effect (Makasi and Govender, 2014). The unit value of an imported product from Vietnam represents the price Thai importers are willing to pay for product quality from Vietnam. Whereas the unit value of an exported product to Vietnam is an alternative for Thai importers who want to replace the imported product with a local product. The higher VPD ratio indicates that the quality of products imported from Vietnam is higher. Thai producers/importers are willing to pay more for imported products of better quality even though the price of those products may be higher than that of exported or local products. The lower VPD ratio indicates that the imported products are of lower quality compared to the local products since Thai producers/importers are able to switch from imported to local products. In this paper, 19 products (see the list of product names on the website: www.customs.go.th) from the iron and steel industry at the HS 4-digit level are observed, in order to examine the pricing behavior and impact of VPD on ERPT. Monthly data were obtained for analysis from the Thailand Trading Report, the Ministry of Commerce, Thailand.

Methodology

Following the framework of the extended Dixit-Stiglitz model (Dixit and Stiglitz, 1977) in Dornbush (1987), this paper estimates the degree of ERPT by regressing the marginal cost, represented by the consumer price index (CPI) and the competing price of a product represented by the producer price index (PPI) and exchange rate (EX) on the import price index (IMP). Previous papers such as those produced by Yang (1997), Bussiere and Peltonen (2014), and Hu et al. (2015) developed the second stage estimation process by regressing the degree of ERPT from first stage regression on product differentiation. In this paper, the change in exchange rate interacts with VPD, indicating the effect of vertical product differentiation as in (2).

$$\ln(IMP_t) = \alpha_{0,i}+\beta_{1,i}\ln(CPI_t) + \beta_{2,i}\ln(PPI_t) + \beta_{3,i}(\ln(EX_t)\times VPD_{i,t}) + e_{i,t} \quad (2)$$

where IMP_t is the import price index for the iron and steel industry at time t.

CPI_t is the consumer price index, as a proxy for marginal cost, at time t.

PPI_t is the producer price index, as a proxy for competing price, at time t.

$VPD_{i,t}$ is the vertical product differentiation between imported and local products i at time t.

EX_t is the nominal exchange rate between the Thai Baht (THB) against the Vietnamese Dong (VND). An increase in EX_t indicates a depreciation in THB.

$\beta_{3,i}$ is the degree of exchange rate pass-through to import price interacted with the quality of product i. Following Shin et al. (2014), the exchange rate (EX_t) in (2) is decomposed in order to estimate a long-run relationship and the impact of exchange rate asymmetry as follows:

$$EX_t = EX_0 + EX_t^+ + EX_t^- \quad (3)$$

$$\text{where} \quad EX_t^+ = \sum_{t=1}^{n} EX_t^+ = \sum_{t=1}^{n} \max(\Delta EX_t ,0) \quad (4)$$

$$EX_t^- = \sum_{t=1}^{n} EX_t^- = \sum_{t=1}^{n} \min(\Delta EX_t ,0) \quad (5)$$

EX_t is the nominal exchange rate of THB/VND, EX_0 is the value of the exchange rate at time 0, EX_t^+ is the partial sum process of positive changes, and EX_t^- is the partial sum process of negative changes. Therefore, EX_t^+ and EX_t^- capture periods of THB depreciation and appreciation, respectively. Then, substituting EX_t in (2) by (3), the Nonlinear Autoregressive Distributed Lag (NARDL) with the lag structure p, q, r, and s to investigate the long-run relationship of exchange rate pass-through to import price is represented as follows:

$$\begin{aligned}\Delta\ln(IMP_t) = {} & \alpha_i + \rho_i\ln(IMP_{t-1}) + \beta_{1,i}\ln(CPI_{t-1}) + \beta_{2,i}\ln(PPI_{t-1}) + \beta_{3,i}^{+}(\ln(EX_{t-1}^{+})\times VPD_{i,t}) + \\ & \beta_{3,i}^{-}(\ln(EX_{t-1}^{-})\times VPD_{i,t}) + \sum_{j=1}^{n-1}\theta_i\Delta\ln(IMP_{t-j}) + \sum_{j=0}^{q-1}\left(\pi_i^{+}\Delta\ln(EX_{t-j}^{+})+\pi_i^{-}\Delta\ln(EX_{t-j}^{-})\right) + \\ & \sum_{j=0}^{r-1}\gamma_{1,i}\Delta\ln(CPI_{t-j}) + \sum_{j=0}^{s-1}\gamma_{2,i}\Delta\ln(PPI_{t-j}) + \epsilon_{i,t}\end{aligned} \quad (6)$$

where

$-\frac{\beta_{3,i}^{+}}{\rho_i}$ represents the long-run ERPT coefficients associated with THB depreciation for product i

$-\frac{\beta_{3,i}^{-}}{\rho_i}$ represents the long-run ERPT coefficients associated with THB appreciation for product i

π_i^{+} represents the short-run ERPT coefficients associated with THB depreciation for product i

π_i^{-} represents the short-run ERPT coefficients associated with THB appreciation for product i

Eq. (6) is estimated for 19 products in the iron and steel industry. The lag structure in Eq. (6) is automatically selected using Akaike information criterion (AIC) with the four maximum lags. Therefore, Eq. (6) allows asymmetric pass-through in both the short run and long run with the effect of VPD. In addition, the PSS test used by Persaran et al. (1996; 2001) is applied to assess the significance of the long-run relationship among variables in the NARDL. The null hypothesis for the absence of a long-run relationship is as follows:

$$H_{0,1}: \rho_i = \frac{\beta^{+}_{3,i}}{\rho_i} = \frac{\beta^{-}_{3,i}}{\rho_i} = \frac{\beta_{1,i}}{\rho_i} = \frac{\beta_{2,i}}{\rho_i} = 0$$

Lastly, both long-run and short-run asymmetric pass-through is examined using the standard Wald test. The null hypothesis of long-run symmetry is set as:

$$H_{0,2}: \frac{\beta^{+}_{3,i}}{\rho_i} = \frac{\beta^{-}_{3,i}}{\rho_i}$$

and the null hypothesis of short-run symmetry is

$$H_{0,3}: \pi^{+}_{i} = \pi^{-}_{i}$$

Empirical Results

The results are presented in three sections. Firstly, the descriptive statistics and unit root test for the dataset are provided in Table 3. Secondly, the ERPT results at aggregate level are presented in Table 4. Finally, the impact of VPD associated with exchange rate movement on the import price index is presented in Table 5.

In Table 3, the average VPD ratio ranges from 0.5663 to 104.0639. Product 7223, consisting of wire in stainless steel, has the highest VPD ratio, suggesting that the product quality from Vietnam tends to be higher than from Thailand. Product 7225, consisting of flat-rolled steel, with a width of 600 mm or more, has the lowest VPD ratio, indicating that the product quality from Vietnam is lower than from Thailand. For the unit root test, the Augmented Dickey Fuller is applied. The IMP, PPI, and CPI are at first difference but 19 VPDs are at level. The null hypothesis for the presence of a unit root is rejected for IMP, PPI, and CPI, indicating that these three variables are all stationary at the 1% significance level. Therefore, the null hypothesis is rejected for the 17 products, suggesting that their VPD ratios are stationary at the 10% significance level. Only two products (7213 and 7228) are not rejected, suggesting the existence of unit roots in these two series.

Basically, the ERPT to import price, without the impact of product quality or VPD, is estimated at the aggregate level as shown in Table 4. The estimation of ERPT to import prices at the aggregate level shows that, in the long run, appreciation ($\frac{\beta^{-}_{3,i}}{\rho_i}$) is more likely to pass-through than depreciation ($\frac{\beta^{+}_{3,i}}{\rho_i}$). The results infer that the import price tends to decrease by 1.1% following a strengthening of the THB at the 1% significance level. Meanwhile, the import price tends to increase 0.24% following a weakening of the THB but is not statically significant. This infers a complete pass-through when THB appreciates. However, the response to a depreciation in the THB refers to partial pass-through but not significant. These findings contradict those in previous papers such as Bacchetta and Wincoop (2005) and Brun-Aguerre et al. (2017) in that ERPT asymmetry is mostly found when domestic currency depreciates. It is likely that iron and steel products traded between Thailand and Vietnam are invoiced in VND since the import price decreases when the THB appreciates. In the short run, the ERPT illustrates a partial pass-through but it is not significant when the THB depreciates or appreciates. However, the Wald test does not confirm the asymmetry of ERPT at aggregate level in both the long run and short run. The PSS test in the final column finally confirms the long-run relationship among variables at the 1% significance level.

Table 3 Descriptive statistics and Unit Root Test

	Mean	**Maximum**	**Minimum**	**Std. Dev.**	**ADF**
ΔIMP	0.0137%	2.6000%	-2.2500%	0.8124%	-4.8540***
ΔPPI	0.0340%	2.4100%	-1.7900%	0.7327%	-9.3793***
ΔCPI	0.1175%	1.3700%	-0.6600%	0.2920%	-7.3845***
			VPD		
	Mean	**Maximum**	**Minimum**	**Std. Dev.**	**ADF**
7202	0.7380	20.9689	0.0138	2.3660	-6.6136***
7204	2.7244	96.8819	0.0495	8.8066	-60.1458***
7208	48.8321	5563.1360	0.0058	507.6370	-10.8378***
7209	1.0292	8.5843	0.0022	1.0701	-8.74151***
7210	0.7359	1.1311	0.4353	0.1112	-6.8530***
7211	0.6125	8.1067	0.1209	0.7794	-3.0830**
7212	0.6013	1.2376	0.2753	0.1809	-3.9489***
7213	0.6319	2.3927	0.0024	0.4510	-1.1957

Table 3 (Continued)

	Mean	Maximum	Minimum	Std. Dev.	ADF
7215	1.2917	29.1608	0.3090	2.8384	-9.5654***
7216	0.7441	3.2416	0.0132	0.5389	-6.2654***
7217	0.8324	1.4774	0.0483	0.1890	-4.3201***
7219	1.4675	1.9433	0.7535	0.3690	-4.6924***
7220	1.2160	24.2422	0.0244	2.5973	-10.6414***
7222	1.8921	13.4177	0.0137	3.0631	-4.8245***
7223	104.0639	1640.4690	0.0239	293.5678	-8.6435***
7225	0.5663	2.1464	0.0040	0.4363	-2.7362*
7226	0.7815	6.6842	0.0263	1.3633	-3.6114***
7228	1.7039	2.3789	0.2348	0.7956	-1.9185
7229	1.1131	2.7697	0.1665	0.3999	-5.5631***

Notes: The last column shows the T-statistic for ADF testing. Lags are chosen according to the Schwarz Information Criterion, allowing for a maximum lag length of 12. *, **, and *** indicating significance at the 10%, 5%, and 1% levels, respectively.

Table 4 The exchange rate pass-through coefficient at aggregate level

	Long-Run ERPT			Short-Run ERPT			PSS test
	$\frac{\beta^-_{3,i}}{\rho_i}$	$\frac{\beta^+_{3,i}}{\rho_i}$	$Wald_{LR}$	π^-_i	π^+_i	$Wald_{SR}$	
Aggregate	1.10***	0.24	-0.93	-0.12	-0.09	-0.21	7.14***

Notes: $\frac{\beta^+_{3,i}}{\rho_i}$ and $\frac{\beta^-_{3,i}}{\rho_i}$ are the long-run ERPT coefficients associated with THB depreciation and appreciation, respectively. π^+_i and π^-_i are the short-run ERPT coefficients associated with THB depreciation and appreciation, respectively. The $Wald_{LR}$ and $Wald_{SR}$ represent the t-statistic of the Wald test for long-run symmetry and short-run symmetry. The PSS test shows the F-statistic of the bounds test, while *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Whereas the previous section estimates the ERPT at aggregate level, this section uses Eq. (6) to determine the coefficients of exchange rate pass-through for appreciation and depreciation regarding the quality of 19 products at the HS 4-digit code. The VPD interacts with the exchange rate to see the impact of product quality on the import price. Specifically, a positive coefficient of $\frac{\beta^{+}_{3,i}}{\rho_i}$ indicates a higher import price when THB depreciation is associated with higher VPD, suggesting that the quality of iron and steel imported from Vietnam is better than that of Thailand. Thai importers still import these quality products even if the THB depreciates and the import price increases. On the other hand, a positive coefficient of $\frac{\beta^{-}_{3,i}}{\rho_i}$ indicates a lower import price when THB appreciation is associated with lower VPD, suggesting that the quality of iron and steel produced in Thailand is better than that of Vietnam. Therefore, Thai importers reduce their imports and substitute them with local steel when the THB appreciates. The results in Table 5 indicate that most ERPT coefficients of depreciation are greater than those of appreciation in the long run. Particularly, the degree of ERPT regarding the quality of five products (7212, 7213, 7215, 7222, and 7229) is positive and significant at the 10% level. This result confirms the work of Hu et al. (2015), who indicate that the higher product quality strength exchange rate pass through. In addition, Bacchetta and Wincoop (2005) explain that if exporters produce differentiated products, they can control price in term of own currency, i.e, producer currency pricing, resulting in an increased ERPT. So, importance result suggests that the ERPT associated with THB depreciation is stronger than for THB appreciation. Specifically, the degree of ERPT associated with product quality is mostly higher than the degree of ERPT at aggregate level, inferring that the product quality of these five items affects the degree of ERPT to import price. For the short-run analysis, the results for 11 products clearly show partial pass-through and are significant at the 10% level. The impact of ERPT associated with THB depreciation is, therefore, greater than for THB appreciation.

Table 5 Exchange rate pass-through coefficients regarding the quality of 19 products

	Long-Run ERPT			Short-Run ERPT			PSS test
	$\frac{\beta^-_{3,i}}{\rho_i}$	$\frac{\beta^+_{3,i}}{\rho_i}$	$Wald_{LR}$	π^-_i	π^+_i	$Wald_{SR}$	
7202	2.56	3.90	0.40	-0.03***	-0.04***	3.11***	6.21***
7204	1.03	1.76	0.70	0.02**	0.03**	-2.38**	5.69***
7208	0.30	0.49	0.17	-0.002	-0.003	1.15	4.28**
7209	1.25	2.19	1.10	-0.01	-0.02	1.11	8.41***
7210	1.47	1.92	0.51	-0.14***	-0.22***	2.97***	10.22***
7211	1.07	1.14	0.07	-0.003	0.002	-0.35	4.17**
7212	1.30***	1.00***	-1.67*	-0.13***	-0.11***	-0.76	12.07***
7213	0.59	1.71**	3.07***	-0.05	-0.10*	1.94*	8.74***
7215	1.29*	3.62*	1.73*	0.01	0.02	-1.17	4.70***
7216	0.11	0.98	2.01**	0.02	0.04	-2.27**	8.73***
7217	3.44	-1.43	-0.18	-0.02	-0.03	0.30	6.26***
7219	-1.59	-0.52	0.38	-0.04**	-0.07**	2.23**	5.59***
7220	0.63	1.01	0.43	-0.01	-0.01	1.44	4.52***
7222	0.62*	0.88**	2.30**	-0.03***	-0.04***	3.56***	6.68***
7223	-0.01	0.01	0.03	-0.00	-0.00	0.99	4.73***
7225	10.01	26.29	0.02	-0.04**	-0.07**	1.92*	3.59**
7226	-0.12	-0.01	0.46	-0.02*	-0.03**	2.89***	4.12**
7228	-0.35	-0.27	0.39	-0.06***	-0.09***	3.58***	6.14***
7229	1.04**	1.53**	1.85*	-0.04**	-0.05*	1.29	8.18***

Notes: $\frac{\beta^+_{3,i}}{\rho_i}$ and $\frac{\beta^-_{3,i}}{\rho_i}$ are the long-run ERPT coefficients associated with THB depreciation and appreciation, respectively. π^+_i and π^-_i are the short-run ERPT coefficients associated with THB depreciation and appreciation, respectively. The $Wald_{LR}$ and $Wald_{SR}$ represent the t-statistic of the Wald test for long-run and short-run symmetry. The PSS test shows the F-statistic of the bounds test. While *, **, and *** indicates significance at the 10%, 5%, and 1% levels, respectively.

In addition, the Wald test confirms asymmetric pass-through at the 10% significance level for six products (7212, 7213, 7215, 7216, 7222, and 7229) in the long run and 10 products (7202, 7204, 7210, 7213, 7216, 7219, 7222, 7225, 7226, and 7228) in the short run. Lastly, the PSS test in the final column confirms the long-run relationship among variables in Eq. (6) at the 5% significance level.

Robustness Test

In this section, THB/USD are replaced with THB/VND in Eq. (6) in order to see the effect of the invoiced currency. The robustness results are presented in Table 6. The results in the long run show: (1) At the aggregate level, appreciation creates more pass-through to the import price than depreciation at the 5% significance level, which is consistent with the results shown in Table 5. (2) Regarding the quality of 19 products, only two coefficients of ERPT for depreciation are greater than those for appreciation at the 10% significant level, suggesting that ERPT associated with THB depreciation is significantly greater than THB appreciation. (3) The degree of ERPT at aggregate level in comparison to the quality of three products (7212, 7213, and 7229) is higher and statistically significant at the 10% level, suggesting that the quality of these three items affects the degree of ERPT to import prices. For the short-run analysis, only six products (7210, 7213, 7219, 7225, 7228, and 7229) show partial pass-through with ERPT having a greater impact following THB depreciation at the 10% significance level. The level of ERPT significance in Table 6 is lower than that shown in Table 5. In addition, the Wald test confirms asymmetric pass-through at the 10% significant level for only two products (7212 and 7213) in the long run and for three products (7216, 7222, and 7229) in the short run. The statistically significant asymmetry in Table 6 is less than that shown in Table 5. This may be partly explained by most invoices for trade conducted between Thailand and Vietnam being in THB/VND, rather than THB/USD. This implies a tendency to use local currency when conducting trade among AEC members. Lastly, the PSS test in the final column confirms the long-run relationship among variables at the 5% significance level, which is similar to the results presented in Table 5.

Concluding Remarks

This paper aims to investigate the impact of ERPT in response to the quality of iron and steel traded between Thailand and Vietnam by observing 19 products at the HS 4-digit level to examine the degree of quality on the import price index. The product quality in this paper is measured using vertical product differentiation (VPD) and studying monthly data from January 2010 to December 2019. The bilateral nominal exchange rates of THB/VND and THB/USD are used to measure the degree of ERPT. The NARDL framework is applied to measure the asymmetric pass-through at aggregate level as well as ERPT regarding the quality of 19 products. The empirical results indicate that exchange rate pass-through at aggregate level is lower when the THB depreciates and higher when the THB appreciates. It could be that iron and steel traded between Thailand and Vietnam are invoiced in VND, suggesting the higher market power of the Vietnamese iron and steel industry. When the product quality interacts with the exchange rate and is used for ERPT estimation, the ERPT of depreciation is greater than that for appreciation both in the long and short run. Particularly, the degree of ERPT associated with product quality is mostly higher than the degree of ERPT at aggregate level, inferring that product quality affects the degree of ERPT to import prices. Ultimately, asymmetric ERPT is confirmed in the long run as well as in the short run.

The results have important implications for Thailand policy makers and firms in iron and steel industry. A main finding indicates that if the quality product from Vietnam is higher than Thailand, i.e., the higher VPD, this increases the degree of ERPT associated with THB depreciation. Hence, the government should encourage economic cooperation with business sectors, by enhancing the way of increase the quality of iron and steel export from Thailand to Vietnam.; Consequently, it will weaken the degree of ERPT to import prices in iron and steel industry. In other words, this is a regard to the price stability, including future competitiveness of Thailand economy

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