Economics Bulletin

Volume 38, Issue 4

The heterogeneous impact of oil price on exchange rate: Evidence from Thailand

Chee-Hong Law
School of Social Sciences, Universiti Sains Malaysia

Abstract

Oil prices are expected to negatively affect the value of an oil-importing country's currency. Nonetheless, there have been few attempts to examine this claim using different quantiles of exchange rate. Examining the data from January 2000 to October 2017, this study focuses on the large appreciation and depreciation exchange rate, which are represented by the extreme quantiles. Breusch-Pagan heteroscedasticity results have shown using quantile regression to be an appropriate approach to understanding oil price and currency value. The findings conclude that the oil prices only depreciate the Thailand exchange rate in the cases of large appreciation, and this is explained the argument that the extreme large appreciation of exchange will be more sensitive to fundamental financial variables, including world oil prices. The outputs also reject previous findings that oil prices do not have any impact on Thailand's exchange rate, which is a finding that provides more justification to examine the heterogeneous reactions.

I thank Universiti Sains Malaysia for their financial support via USM short-term research grant [grant numbers:304/PSOSIAL/6313244]
Citation: Chee-Hong Law, (2018) "The heterogeneous impact of oil price on exchange rate: Evidence from Thailand ", *Economics Bulletin*, Volume 38, Issue 4, pages 1748-1756
Contact: Chee-Hong Law - cheehong@usm.my.
Submitted: July 10, 2018. **Published:** October 10, 2018.

1. Introduction

Crude oil is one of the most important commodities in modern history. It is not only a crucial input in manufacturing production but also affects several economic variables such as economic growth, unemployment, investment and inflation (Berument, Ceylan and Dogan, 2010; Chang and Wong, 2003; Rafiq, Salim and Bloch, 2009). More importantly, previous studies have suggested that the movement in the oil price will affect the exchange rate (Amano and Norden, 1998; Beckmann and Czudaj, 2013; Papadamou and Markopoulos, 2012). According to Basher, Haug and Sadorsky (2015), oil price affects the exchange rate via the terms of trade channel and the wealth channel. Under the terms of trade channel, the oil price increases are expected to worsen the trade balance and cause the currencies of oil importing countries to depreciate, while the opposite effect occurs in the oil exporting nation. On the other hand, the wealth channel causes the transfer of wealth from oil importers to oil exporters during portfolio reallocation and current account imbalance, causing real depreciation (appreciation) of the exchange rates of oil importing (oil exporting) countries.

In this paper, I examine the heterogeneous impact of oil price on the different quantiles of exchange rate in Thailand. Research to examine the linkages between oil price and exchange rate in Thailand is relatively scant compared research on the implications of oil price on the other macroeconomic variables. Among the relevant papers are those of Jiranyakul (2015) who discovers that while the oil price and real effective exchange rate are not cointegrated, the Granger causality test indicates that the volatility of real effective exchange rate is affected by the volatility of oil price. Basnet and Upadhyaya (2015) show that the initial reaction of real effective exchange rate is positive to a shock of oil price in a structural vector autoregression model but that the reactions become small after the fourth quarters. Despite this positive relationship, it is important to notice that the reaction is statistically insignificant. Therefore, it is generally found that the oil price has limited impact on real exchange rate in Thailand.

From the relevant literature, the extreme high and extreme low exchange rate could have different reactions to the changes in oil prices. However, there is no consensus on how the reaction could be different. Su, Zhu, You and Ren (2016) suggest that the large depreciation of currency will have greater responses to the exchange rate due to the central bank intervention effect and the export selection effects. Otherwise, the reserve accumulation to mitigate the exchange rate's excessive appreciation will mitigate the reaction of the exchange rate to the changes in oil prices. Nonetheless, the relationship could operate in the opposite manner where the currency intervention to alleviate sharp depreciation will cause the currency to be more stable against the changes of its determinants. Another hypothesis to consider is that when the exchange rate is in the extreme high and extreme low quantiles, the opportunities of gaining profit from exchange rate transaction will be greater (Tsai, 2012). In this market condition, the exchange rate will show more sensitivity to new economic development, including those of the commodity market because it offers profit-taking or buying opportunities. Hence, it is fair to conclude that the theoretical impacts of oil prices on exchange rate at the extreme quantiles are inconclusive.

The importance of this paper can be seen by the fact that being an oil importing country, the changes in the oil prices are expected to have a significant impact on the Thai economy, especially after the implementation of a floating exchange rate in the late 1990s. Moreover, this paper contributes to the current literature for being the first attempt to examine this issue by considering the reaction in different quantiles of exchange rate in Thailand. The understanding of the exchange rate's heterogeneous reaction to oil price at different quantiles will reveal more information for exchange rate management and investment strategy compared to a linear model. Furthermore, the quantile regression allows the estimation to be more efficient when the error terms are non-normal. This advantage is relevant here because the exchange rate distribution is typically not normally distributed (Su et al., 2016).

In this paper, the extreme values of exchange rate at 1%, 5%, 10%, 90%, 95% and 99% quantile are examined. I treat the first three quantiles as the large depreciation and the last three quantiles as the large appreciation. The same interpretation is also applied by Su et al. (2016). This study is quite similar to the research conducted by Su et al. (2016) who examine the similar issue in seven developed countries. Their conclusions support the existence of heterogeneous reactions of exchange rate in different quantiles. The reactions are also larger in the cases of excessive appreciation and depreciation. However, this paper constructs an exchange rate equation from the variables from the monetary approach and enlarges the model by price level and world oil price, whereas Su et al. (2016) focus on various shocks of oil price that are theoretically unpredictable. This paper is organised as follows. Section 2 presents the data description and Section 3 explains the methodology. The results and conclusion are provided in Section 4 and Section 5, respectively.

2. Data Description

This paper covers Thailand's monthly data from January 2000 to October 2017. The dependent variable, i.e. the real effective exchange rate is collected from the Bank for International Settlements. The world oil price is proxied by the spot price of West Texas Intermediate (WTI) and is provided by Federal Reserves of St. Louis. In addition, Datastream also provides the data about the money supply (broad money), output (index of industrial production), price level (consumer price level) and stock market index (SET index). The nominal data is covered into the real terms by deflating them with the consumer price index, except for the money market rate where the real terms are derived by deducting inflation rate from the nominal rate. Data of the index of producer price of United States it is also used convert the nominal oil price to the real terms and will be applied to test the robustness of the results. The same conversion is also made by Juncal and Fernando (2014). The rationale to measure the WTI price in the real terms is also supported by Papadamou and Markopoulus (2012) who argue that real oil price is one of the factors that cause the deviation from the Purchasing Price Parity theory. Equally important, Amano and Norden (1998) show that real oil price performs as a proxy for exogenous changes in the terms of trade and affects real exchange in Japan, Germany and the US. Finally, all variables, except for the money market rate are transformed into logarithm form.

3. Methodology

This paper estimates the following equation as the baseline model:

$$LREER = \beta_0 + \beta_1 LRIPI + \beta_2 LRBROADM + \beta_3 RMMR + \beta_4 LCPI + \beta_5 LRSTOCK + \beta_6 LWOIL \quad (1)$$

where $LREER$ is the natural logarithm of real effective exchange rate, $LRIPI$ is the natural logarithm of real index of industrial production, $LRBROADM$ is the natural logarithm of real broad money, $RMMR$ is the real money market rate, $LCPI$ is the natural logarithm of consumer price index, $LRSTOCK$ is the natural logarithm of stock market index and $LWOIL$ is the natural logarithm of WTI oil price. In this paper, the higher LREER indicates the appreciation of Thailand's currency. I hypothesise that a higher $LRIPI$ and $LRSTOCK$ are expected to show a positive sign. In particular, an increase in $LRIPI$, $RMMR$ and $LRSTOCK$ are expected to cause the currency appreciation by increasing demand for domestic money. For $LRBROADM$, $LCPI$ and $LWOIL$, the opposite effect is expected to occur. The inflation and higher money supply will cause lower exports. Eventually, the value of domestic currency will depreciate. Finally, the exchange rate reacts negatively to higher oil price through the terms of trade channel and wealth channel.

To illustrate the methodology, assuming that a linear model of (1) is expressed as below

$$REER_t = X_t\beta + \mu_t$$

Where $REER_t$ is the real effective exchange rate, X_t is $K \times 1$ regressors, β is the coefficients and μ_t is the error term. The quantile regression aims to estimate the coefficients for quantiles beside the median or 50th quantile. The computation assumes that τ stands for quantile variable and the conditional quantile function is expressed as

$$Q_F(\tau|X) = X'\beta(\tau)$$

This conditional quantile function is estimated by solving

$$\min_{\beta \in R^P} \sum_{t=1}^{n} \rho_\tau \left(E_t - X'\beta\right)$$

To minimise the following equation

$$\min_{\hat{\beta}} \left[\tau \sum_{E_t \geq \hat{\beta} X_t} \left|E_t - \hat{\beta} X_t\right| + (1-\tau) \sum_{E_t < \hat{\beta} X_t} \left|E_t - \hat{\beta} X_t\right| \right]$$

where $\hat{\beta}X_t$ is an approximation to τ-th conditional quantile of REER. The closer the value of τ to zero, $\hat{\beta}X_t$ will show the characteristic of REER at the left tails of the conditional distribution and vice versa. In terms of testing the robustness of the result, besides converting the nominal world oil prices into real terms, I also included a dummy to capture the implication due to the 2008 global financial crisis. The dummy will take the value of one for the period of crisis (September 2008 to March 2009) and zero for the other period. The models for both robustness checking are presented by equation (2) and (3).

$$LREER = \alpha_0 + \alpha_1 LRIPI + \alpha_2 LRBROADM + \alpha_3 RMMR + \alpha_4 LCPI + \alpha_5 LRSTOCK + \alpha_6 LRWOIL \quad (2)$$

$$LREER = \gamma_0 + \gamma_1 LRIPI + \gamma_2 LRBROADM + \gamma_3 RMMR + \gamma_4 LCPI + \gamma_5 LRSTOCK + \gamma_6 LWOIL + \gamma_7 DUM \quad (3)$$

Where $LRWOIL$ is the natural logarithm of real WTI oil price and DUM is the dummy of 2008 global financial crisis. The estimation is done by using the *sqreg* command in Stata and the bootstrap standard errors are obtained from 500 bootstrap replication.

4. Results

The results of the Breusch-Pagan heteroscedasticity test are provided first to detect the existence of heteroscedasticity on the ordinary least squares (OLS) estimation because the heteroscedasticity will provide the justification to examine the function in different quantiles. The results are available in Table I and they indicate that all estimated models contain heteroscedasticity by the rejection of null hypothesis of the Breusch-Pagan heteroscedasticity test at the 10 percent significance level (i.e. p-values are less than 0.10).

Next, Table II to Table IV contains the quantile regression output from equation 2 to equation 4, respectively. According to the figures in Table II, the OLS estimation, represented by column q=0.50, indicates the LCPI are statistically significant where a higher price level appreciates REER in Thailand by 0.79 percent. The positive coefficient of LCPI is not in accordance to the traditional expected sign. However, this result could indicate that a higher inflation inflates the expected higher interest rate in the future, and this will boost the demand for domestic currency, causing appreciate of currency. Besides, Chowdhury (2002) found that according to neoclassical theory, inflation contributes to the real appreciation of currency.

Table I: Breusch-Pagan heteroscedasticity test

Model	Breusch-Pagan test outputs
Equation (1)	52.53 (0.000)
Equation (2)	53.71 (0.000)
Equation (3)	51.57 (0.000)

Note: The values inside the parentheses are the p-values.

In the other quantiles, some differences can be observed. More variables are found to be statistically significant when there are large appreciation and depreciation of REER compared to the OLS estimation. Besides, the size of the coefficient is also larger, in general, for the upper extreme quantiles, representing that the large appreciation of Thai currency is more sensitive to the independent variables of this model. The relatively high sensitivity of Thai currency during the large appreciation could be attributed, as argued by Tsai (2012), to the more active exchange rate trading following greater trading opportunities. The variable of the interest, which is the world oil price, shows negative sign and this is supported by the theory that oil importing countries will suffer from currency depreciation during a hike in the oil price. Furthermore, this variable is only statistically significant during large appreciation, indicating that REER is more sensitive to the increase in oil prices during currency appreciation. Again, the increase of the oil price during that period serves as an excuse for the currency investors to realise their profit when the value of currency is in the high level, causing the depreciation in the REER. Furthermore, during the large appreciation quantile, the exchange rate has been found to demonstrate statistically significant reactions to all variables except for the LRIPI. Although the price level has a positive sign, which is the same the OLS estimation, the other variables show a sign that is in accordance with expectation.

However, there are some changes in the statistical significance of the variables in the large depreciation quantile. In particular, a higher LRBROADM in the large depreciation quantiles will appreciate REER, although the impact is statistically insignificant. The appreciation effect could be due to the imported inflation following the large depreciation of currency that amplifies the price level effect and expected inflation effect of an increase in the money supply. As a result, the interest rate could be higher and lead to currency appreciation. LRIPI and LRSTOCK, on the other hand, has shown a negative sign and the results are statistically significant in almost all examined extreme lower quantiles. This unconventional sign of LRIPI could be explained by the intention to preserve the wealth generated from economic growth by transferring wealth (denominated in domestic currency) to foreign countries. Iteratively, the demand for foreign currencies will increase, leading to depreciation of Thai REER. Similarly, the depreciation effect from higher stock market prices might be caused by the role of the stock market as the substitution for money. In detail, the higher stock market prevents the erosion of wealth due to currency depreciation. Hence, the substitution effect will surpass the income effect, causing the depreciation of REER. Finally, RMMR is statistically insignificant during the extreme low quantiles even though the sign is in accordance with the traditional theory.

Table II: Baseline model (equation 1)

Variables	q=0.01	q=0.05	q=0.10	q=0.50	q=0.90	q=0.95	q=0.99
LRBROADM	0.0556	0.00949	0.0194	-0.105	-0.586***	-0.795***	-0.806***
	(0.0520)	(0.0808)	(0.0798)	(0.103)	(0.155)	(0.174)	(0.181)
LRIPI	-0.0722**	-0.0651**	-0.0205	-0.00511	0.0237	-0.0800	0.00845
	(0.0351)	(0.0293)	(0.0222)	(0.0595)	(0.0956)	(0.0896)	(0.0812)
RMMR	0.00329	0.00333	0.00134	0.00154	0.0208***	0.0250***	0.0360***
	(0.00289)	(0.00315)	(0.00242)	(0.00226)	(0.00597)	(0.00615)	(0.00959)
LRSTOCK	-0.0340**	-0.0364**	-0.0538***	0.00670	0.124***	0.174***	0.151***
	(0.0165)	(0.0142)	(0.0131)	(0.0161)	(0.0364)	(0.0396)	(0.0439)
LCPI	0.643***	0.754***	0.724***	0.793***	1.376***	1.760***	1.794***
	(0.108)	(0.163)	(0.160)	(0.221)	(0.338)	(0.356)	(0.361)
LWOIL	0.000821	-0.00969	0.00235	-0.0160	-0.0855**	-0.113***	-0.144***
	(0.00949)	(0.0118)	(0.0123)	(0.0202)	(0.0344)	(0.0369)	(0.0415)
C	1.365***	1.126***	1.223***	1.471***	1.133	0.359	0.431
	(0.240)	(0.347)	(0.341)	(0.511)	(0.833)	(0.838)	(0.814)
Observations	214	214	214	214	214	214	214

Note: Standard errors in parentheses. C represents constant term, *** p<0.01, ** p<0.05, * p<0.1

Table III: robustness model (equation 2)

Variables	q=0.01	q=0.05	q=0.10	q=0.50	q=0.90	q=0.95	q=0.99
LRBROADM	0.0554	0.0671	0.0196	-0.104	-0.601***	-0.794***	-0.840***
	(0.0434)	(0.0772)	(0.0735)	(0.0975)	(0.141)	(0.172)	(0.198)
LRIPI	-0.0722**	-0.0595*	-0.0204	-0.0141	-0.0155	-0.130	-0.0773
	(0.0347)	(0.0308)	(0.0232)	(0.0648)	(0.0915)	(0.0866)	(0.0843)
RMMR	0.00331	0.000786	0.00136	0.00158	0.0205***	0.0236***	0.0315***
	(0.00293)	(0.00312)	(0.00236)	(0.00227)	(0.00635)	(0.00635)	(0.00863)
LRSTOCK	-0.0339**	-0.0469***	-0.0540***	0.00678	0.127***	0.174***	0.166***
	(0.0151)	(0.0143)	(0.0124)	(0.0170)	(0.0350)	(0.0411)	(0.0451)
LCPI	0.644***	0.644***	0.725***	0.780***	1.342***	1.687***	1.736***
	(0.0900)	(0.149)	(0.139)	(0.197)	(0.293)	(0.327)	(0.374)
LRWOIL	0.000814	0.00525	0.00287	-0.0136	-0.0847***	-0.105***	-0.134***
	(0.00895)	(0.0120)	(0.0120)	(0.0196)	(0.0293)	(0.0333)	(0.0359)
C	1.365***	1.350***	1.228***	1.449***	0.957	0.174	0.171
	(0.222)	(0.344)	(0.325)	(0.501)	(0.797)	(0.839)	(0.929)
Observations	214	214	214	214	214	214	214

Note: Standard errors in parentheses. C represents constant term, *** p<0.01, ** p<0.05, * p<0.1

Table IV: robustness model (equation 3)

Variables	q=0.01	q=0.05	q=0.10	q=0.50	q=0.90	q=0.95	q=0.99
LRBROADM	0.0683	0.0365	0.0311	-0.108	-0.550***	-0.816***	-0.903***
	(0.0416)	(0.0552)	(0.0603)	(0.101)	(0.157)	(0.174)	(0.195)
LRIPI	0.0259	0.00985	0.00765	0.0197	0.0317	-0.0774	-0.0129
	(0.0399)	(0.0281)	(0.0215)	(0.0665)	(0.0947)	(0.0920)	(0.0942)
RMMR	0.00466**	0.00259	0.00136	0.00272	0.0200***	0.0226***	0.0309***
	(0.00216)	(0.00206)	(0.00208)	(0.00272)	(0.00750)	(0.00747)	(0.00931)
LRSTOCK	-0.0820***	-0.0852***	-0.0695***	0.00309	0.123***	0.185***	0.192***
	(0.0185)	(0.0152)	(0.0154)	(0.0168)	(0.0393)	(0.0503)	(0.0576)
LCPI	0.686***	0.771***	0.726***	0.800***	1.284***	1.763***	1.904***
	(0.0870)	(0.105)	(0.114)	(0.226)	(0.399)	(0.390)	(0.412)
LRWOIL	-0.00229	-0.00160	0.00246	-0.0222	-0.0782**	-0.114***	-0.159***
	(0.00875)	(0.00961)	(0.0103)	(0.0210)	(0.0347)	(0.0358)	(0.0424)
DUM	-0.0239**	-0.0260***	-0.0201**	-0.00729	0.0121	0.0146	0.0125
	(0.0115)	(0.00952)	(0.00950)	(0.0128)	(0.0348)	(0.0365)	(0.0412)
C	1.233***	1.007***	1.198***	1.485***	1.356	0.431	0.366
	(0.198)	(0.222)	(0.246)	(0.534)	(1.087)	(1.050)	(1.049)
Observations	214	214	214	214	214	214	214

Note: Standard errors in parentheses. C represents constant term, *** p<0.01, ** p<0.05, * p<0.1

In terms of the robustness estimations, the replacement of nominal oil price by the real oil price does not change the baseline model's estimation and supports the findings above (See Table III). The inclusion of the financial crisis dummy as shown in Table IV also shows consistency in the findings. The crisis dummy is statistically significant at the lower quantiles and demonstrates the depreciation effect which is as expected because there is lower demand for domestic assets from domestic and foreign investors during the crisis and this effect is more obvious during the large currency depreciation because of the larger coefficients and is statistically significant during the extreme lower quantiles.

5. Conclusion

The objective of this paper is to discover the heterogeneous responses of exchange rate in Thailand to several independent variables, including oil prices at different quantiles which has not yet been explored thoroughly. This issue deserves attention because of the importance of oil price and exchange rate to oil-dependent and export-oriented countries such as Thailand. In summary, the heterogeneous reactions to all examined independent variables have been proven and it offers a new perspective to understand the connections among these variables in Thailand. Most importantly, the fluctuation of the oil price will depreciate the real effective exchange rate only during the large appreciation of exchange rate, suggesting that investors should pay greater attention to the oil prices during that period to reduce losses or maximise profits. Finally, the main conclusions are supported by the robustness estimations.

References

Amano, A. R and V. S. Norden (1998) "Exchange rates and oil prices" *Review of International Economics* **6**, 683-694.

Basher, S. A., A. Haug and P. Sadorsky (2016) "The impact of oil shocks on exchange rate: A Markov-Switching approach" *Energy Economics* **54**, 11-23.

Basnet, H. C and P. K. Upadhyaya (2015) "Impact of oil price shocks on output, inflation and the real exchange rate: evidence from selected ASEAN countries" *Applied Economics* **47**, 3078-3091.

Beckmann, J and R. Czudaj (2013) "Is there a homogenous causality pattern between oil prices and currencies oil importers and exporters?" *Energy Economics* **40**, 665-678.

Berument, M. H and N. B. Ceylan and N. Dogan (2010) "The Impact of Oil Price Shocks on the Economic Growth of Selected MENA Countries" *The Energy Journal* **31**, 149-176.

Chang, Y and J. F. Wong (2003) "Oil price fluctuations and Singapore economy" *Energy Policy* **31**, 1151-1165.

Chowhudry, A. (2002) "Does inflation affect economic growth? The relevance of the debate for Indonesia" *Journal of the Asia Pacific* **7**, 20-34.

Jiranyakul, K. (2015) "Oil price volatility and real effective exchange rate: The case of Thailand" *International Journal of Energy Economics and Policy* **5,** 574-579.

Juncal, C and F. P. De Gracia (2014) "Oil price shocks and stock market returns: Evidence for some European countries" *Energy Economics* **42**, 365-377.

Papadamou, S and T. Markopoulos (2012) "The monetary approach to exchange rate determination for a "petrocurrency": the case of Norwegian" *International Advances in Economics Research* **18**, 299-314.

Rafiq, S, R. Salim and H. Bloch (2009) "Impact of crude oil price volatility on economic activities: An empirical investigation in the Thai economy" *Resources Policy* **34**, 121-132.

Su, X., H. Zhu, W. You, and T. Ren (2016) "Heterogeneous effect of oil shocks on exchange rates: evidence from a quantile regression approach" *Springerplus* **5:1187**, 1-21.

Tsai, I-C. (2012) "The relationship between stock price index and exchange rate in Asian markets: A quantile regression approach" *Journal of International Financial Markets, Institutional & Money* **22**, 609-621.