

Further Evidence on Asymmetry in the Impact of Oil Price on Exchange Rate and Stock Price in China using Daily Data

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Abstract

The role of oil price on the macro-economy has been intensely researched. However, oil remains one of the most important energy sources for production. Concerning China, there are projections that the country's energy consumption would have risen to 18 billion barrels per day in the next two decades. Given China's heavy reliance on oil, we reexamine the impact of oil price on the US dollar-Renminbi rate and the Shanghai index using daily data from 4/01/2010 to 29/03/2021. In our analysis, we apply the Nonlinear ARDL technique in the presence of structural breaks and find that oil price has asymmetric impact on exchange rate and stock price in the short-run alone. However, the asymmetry is only in terms of magnitude and not in terms of effect direction. Oil price is found to appreciate the Renminbi vis-à-vis the US dollar and to increase stock price significantly both in the short-run. We find that accounting for structural breaks is necessary for cointegration in using oil price to explain both variables.

Keywords: asymmetric effects, NARDL, structural breaks

1. Introduction

The impact of oil price on the domestic economy has been an intensely researched issues over the years. The underlying rationale behind these researches is that energy is indispensable, and even irreplaceable as a production input (Bjørnland, 2009). Given its importance, energy price movements tend to have a substantial impact on macroeconomic outcomes owing to their influences on production cost and output prices (Bohi, 1989). Among the variables frequently affected by oil price variations are exchange rate and stock price (Salisu & Oloko, 2015; Kumar, 2019). One theoretical explanation for how oil price affects exchange rate suggests that wealth is transferred from the oil-consuming country to the oil-producing country when oil price increases (Bénassy-Quéré, Mignon, & Penot, 2007). This occurs because the increased oil price means that the same quantity of oil is purchased with more of the oil consumer's currency thereby improving the oil producer's balance of payment (Beckmann, Czudaj, & Arora, 2017). According to another explanation, an oil price rise would make the net oil-importer's exports less competitive if its traded sector is energy-intensive, thus leading to a currency depreciation for the oil importer (Amano & van Norden, 1998). The previous explanations, known respectively as the wealth and terms-of-trade effects imply that a net oil-importing country would always experience a currency depreciation when oil price increases. These explanations were modified in a later proposition which stated that the currency depreciation resulting from an oil price increase is more certain for the net oil-exporter in the short-run given rigidities in tastes and production techniques (Beckmann & Czudaj, 2013). Over the long-run, it is possible that residents in both net oil-importing and net oil-exporting countries show a greater preference for the securities of the latter country, such that the wealth and terms-of-trade effects are eliminated. This explanation, known as the portfolio reallocation hypothesis suggests that the long-term impact of oil price changes on exchange rate is tied to portfolio preferences and reallocation between the net oil-importer and net oil-exporter. Indeed, the implicit suggestion is that net oil-producing countries are mostly unindustrialized, having undeveloped and unstable financial systems. Therefore, their residents should exhibit a greater preference for financial investments in the mostly industrialized, net oil-importing countries. This proposition implies that the net oil-importer's currency could appreciate in the long-term for an oil price increase, a possibility that was not mentioned in the earlier explanations (Beckmann et al., 2017).

A look at the empirical literature on oil price's effect on the exchange rate of net-oil importing countries shows mixed evidences but the support for theoretical postulations has been overwhelming (e.g., Faria, Mollick, Albuquerque, & León-Ledesma, 2009; Ou, Zhang, & Wang, 2012; Qianqian 2011; Ju, Zhou, Zhou, & Wu, 2014; Bai & Koong 2018; Khraief, Shahbaz, & Mahalik, 2021; Nazeer, Dingchou, & Onodje, 2021 all covering China; Amano & van Norden, 1998; Bénéassy-Quéré et al., 2007; Lizardo & Mollick, 2010; Turhan, Sensoy, & Hacıhasanoglu, 2014 all covering the US). In the case of net-oil exporting countries, the empirical evidence has also been mixed with some studies conforming with the theory (e.g., Olomola & Adejumo, 2006; Suleiman & Mohammad, 2011; Adeniyi, Omisakin, Olusegun, & Oyinlola, 2012 all covering Nigeria; Hasanoy & Samadoya, 2010 covering Azerbaijan; Jahan-Pavar and Mohannadi, 2011 for Angola & Nigeria; Tiwari, Matascu, & Albulescu, 2013 covering Romania) and others contradicting the theory (e.g., Rautava, 2004 covering Russia; Katun & Wyzan, 2005 covering Kazakhstan; Benhabib, Kamel, & Maliki, 2014 covering Algeria). These mixed evidences on oil price's impact on exchange rate documented for both country types have been attributed to several factors, including methodological differences, exogenous shocks, and policy dynamics which has capacity to alter the observed oil price-exchange rate relationship (Qiang et al., 2019).

In terms of how oil price could influence the stock market the most obvious explanation is that companies' production costs vary directly with oil price changes. Under the assumption of efficient markets, all information about a firm's prospect and value are reflected in its stock price. If that is the case, then present and future impacts of oil price changes would reflect fully on stock prices (Bjørnland, 2009). Moreover, stock prices represent the discounted values of firms' present and future net profits (Wei & Guo, 2017). Since oil price affects production cost, an oil price increase should cause expected profits to fall and stock prices to decrease consequently (Basher, Haug, & Sadorsky, 2012; Kumar, 2019). The theoretical proposition concerning how stock prices respond to oil price changes has not been met with consistent empirical results whether for net oil-consuming or net oil-producing countries. Taking the US as an example of net oil-importing countries, various studies document that stock prices decline significantly when oil prices rise (e.g., Jones & Kaul, 1996; Ghouri, 2006; Nandha & Faff, 2008; Elyasiani, Mansur, & Odusami, 2012; Kang, Ratti, & Yoon, 2014; Lambertides, Savva, & Tsouknidis, 2017; Sakaki, 2019) while others find evidence of a positive relationship (e.g., Al-Mudhaf & Goodwin, 1993; Kilian & Park, 2009; Mollick & Assefa, 2013). Taking China as an example, a substantial part of the empirical evidence contradicts the theory (e.g., Lin, Fang, & Cheng, 2010; Zhang & Chen, 2011; Zhu, Su, Guo, & Ren, 2016; Wei & Guo, 2017; Bai & Koong, 2018; Tian, Li, & Wen, 2021). Using techniques that capture time-varying associations, some studies report that the impact direction of oil price on China stock prices have been dynamic over time (e.g., Broadstock & Filis, 2014; Caporale, Ali, & Spagnolo, 2015; Xiao, Zhou, Wen, & Wen, 2018; Wei, Qin, Li, Zhu, & Wei, 2019). In the net oil-exporting countries some evidences are in favour of the theory (e.g., Filis, Degiannakis, & Floros, 2011; Wang, Wu, & Yang, 2013; Filis & Chatziantoniou, 2014). Bjørnland (2009) however, document that oil price shocks have a positive impact on the Norwegian stock market. Recently, Mokni (2020) found evidence of a predominantly positive relationship between oil price and stock prices of several net oil-exporting countries, including Mexico, Russia, and Venezuela.

These mixed results on oil price's influence on macroeconomic magnitudes is a key motivating factor for the ongoing research around this topic particularly as new methodologies are being developed and popularized. Moreover, crude oil remains the most utilized energy source for production and transportation (IEA, 2020) despite an increasing popularity of the "green movement" and the drive towards sustainable energy. Recent projections affirm that global crude oil consumption is growing and would continue to do so at an average of 950 thousand barrels per day annually over the 2019-25 period (Ritchie & Roser, 2020). In China alone, per capita oil consumption is close to 33% of OECD countries combined. An examination of the historical data reveals that oil consumption in China has grown over the past two decades from 4.7 million to 14.1 million barrels per day and will expand further to nearly 18 million barrels per day by 2040 (Meidan, 2020). These projections are a strong indication that oil price would continue to exert a heavy influence on China's economy, including in her exchange rate and stock markets in the foreseeable future. Based on these expectations, we revisit the role of oil price on the US dollar-renminbi rate and the Shanghai index. Some previous studies examined oil price's role on exchange rate and stock prices in China but none, with the exception of Nazeer et al. (2021), investigated short- and long-run asymmetries in oil price's impact on these variables. Unlike Nazeer et al. (2021), we apply daily data to accommodate greater dynamics in the data generation and extend our data to recent periods. The rest of this paper is structured as follows. Section 2 discusses the data and sources and outlines the methodological strategy. In Section 3 we perform preliminary analysis on the data and present the main results with discussions. Section 4 concludes the paper with final comments.

2. Data and Methodology

For the purpose of this study, we utilize daily data from 4 January 2010 to 29 March 2021 on the US dollar-RMB exchange rate and the Shanghai stock index and use WTI prices to measure oil price. Data for the US dollar-RMB rate and the Shanghai index are obtained from the investing.com site while data for WTI price is obtained from the International Energy Agency (IEA) website. All data are transformed to natural log form to normalize and for ease of interpretation. In order to examine asymmetry in the effect of oil price on both markets we rely on the Nonlinear ARDL (NARDL) technique by Shin et al. (2014) which decomposes oil price's effect in to negative and positive effects. The idea of modelling asymmetries in the impact of oil price on macroeconomic magnitudes date back to Mork (1989) with later variants proposed by other scholars (e.g., Hamilton, 1989; Lee et al., 1995; Hamilton, 2003; Kilian, 2009). In the Mork specification, which this study adopts, a positive oil price change is computed as follows.

$$op_t^+ = \sum_{i=1}^t \max[\Delta op, 0] = \sum_{i=1}^t \Delta op_t^+ \quad (1)$$

A negative oil price change is computed similarly in the following manner.

$$op_t^- = \sum_{i=1}^t \max[\Delta op, 0] = \sum_{i=1}^t \Delta op_t^- \quad (2)$$

In equations (1) and (2) op_t^+ and op_t^- are respectively positive and negative log oil price (op) changes per period which are respectively computed as the cumulative sums of positive and negative changes in the variable from the original data. The NARDL model in this case would assume the following form for the exchange rate model.

$$\begin{aligned} \Delta ex_t = & \beta_{01} + \sum_{i=0}^p \beta_{11j} \Delta ex_t + \sum_{i=1}^q \beta_{21i} \Delta op_t^+ + \sum_{i=1}^q \beta_{31i} \Delta op_t^- + \rho_1 ex_{t-1} + \alpha_{11} op_t^+ \\ & + \alpha_{12} op_t^- + \eta_{1t} \end{aligned} \quad (3)$$

The model for stock price is likewise specified in the following way.

$$\begin{aligned} \Delta sp_t = & \beta_{02} + \sum_{i=0}^p \beta_{12j} \Delta sp_t + \sum_{i=1}^q \beta_{22i} \Delta op_t^+ + \sum_{i=1}^q \beta_{32i} \Delta op_t^- + \rho_2 sp_{t-1} + \alpha_{12} op_t^+ \\ & + \alpha_{22} op_t^- + \eta_{2t} \end{aligned} \quad (4)$$

ex and sp in equations (3) and (4) respectively denote log exchange rate and log stock price. Both models can be reparametrized in the following way to show the Error Correction Term (ECT) whose parameter depicts the speed of adjustment when there is a short-run shock in the model.

$$\Delta ex_t = \sum_{i=0}^p \beta_{11j} \Delta ex_t + \sum_{i=1}^q \beta_{21i} \Delta op_t^+ + \sum_{i=1}^q \beta_{31i} \Delta op_t^- + \rho_1 ECT_1 + \eta_{1t} \quad (5)$$

$$\Delta sp_t = \sum_{i=0}^p \beta_{12j} \Delta sp_t + \sum_{i=1}^q \beta_{22i} \Delta op_t^+ + \sum_{i=1}^q \beta_{32i} \Delta op_t^- + \rho_2 ECT_2 + \eta_{2t} \quad (6)$$

The ECT in both cases are calculated from the following expressions.

$$\rho_1 ECT_1 = \rho_1 (ex_{t-1} - \alpha_{11}^* op_t^+ - \alpha_{12}^* op_t^-) \quad (7)$$

$$\rho_2 ECT_2 = \rho_2 (sp_{t-1} - \alpha_{21}^* op_t^+ - \alpha_{22}^* op_t^-) \quad (8)$$

The short-run parameters, found in equations (3) to (6) are β_{11j} and β_{21j} for the exchange rate model and β_{12j} and β_{22j} for the stock price model. The long-run parameters are actually α_{11}^* and α_{12}^* for the exchange rate model, and α_{21}^* and α_{22}^* for the stock price model which are given by, $\alpha_{11}^* = -\alpha_{11}/\rho_1$, $\alpha_{12}^* = -\alpha_{12}/\rho_1$, $\alpha_{21}^* = -\alpha_{21}/\rho_2$, and $\alpha_{22}^* = -\alpha_{22}/\rho_2$. To test for asymmetric effects, the following hypotheses using

Wald-based F-tests were suggested by Shin et al. (2014): $-\frac{\alpha_{11}}{\rho_1} = -\frac{\alpha_{12}}{\rho_1}$ for the exchange rate model and

$-\frac{\alpha_{21}}{\rho_2} = -\frac{\alpha_{22}}{\rho_2}$ for the stock price model. Correspondingly, the short-run asymmetric tests are tested using the

following hypotheses: $\sum_{i=1}^q \beta_{21i} = \sum_{i=1}^q \beta_{31i}$ for the exchange rate model and $\sum_{i=1}^q \beta_{22i} = \sum_{i=1}^q \beta_{32i}$ for the stock price model. Table 1 shows the summary statistics of the variables.

Table 1. Summary statistic table

Statistic	Log exchange rate	Log Stock Price	Log Oil Price
Mean	1.877	7.935	4.175
Median	1.875	7.972	4.162
Maximum	1.971	8.550	4.731
Minimum	1.799	7.576	2.187
Std. Dev.	0.045	0.182	0.363
Skewness	0.124	-0.020	-0.596
Kurtosis	1.792	2.750	3.438
Jarque-Bera	185.536	7.790	196.500
Probability	0.000	0.020	0.000
Observations	2927	2927	2927

3. Analysis and Discussion

3.1 Preliminary Analysis

The graphical representation of the variables' evolution over the analysis period is presented in Figure 1. We see that all the variables exhibit a pattern of fluctuation during the analysis period. Log exchange rates exhibit a downward trend for most of the periods before 2015 but start an upward trend up till around 2017. Recently, the downward trend can be observed from around mid-2020. A strikingly similar movement pattern to exchange rate can be observed for stock price particularly in the post-2015 periods. The peak of log stock price can be observed around mid-2015 which is followed by a declining pattern up till after 2016 when it stabilized somewhat. Concerning log oil price, substantial changes in its movement pattern occurred around late 2014 owing largely to the supply glut and the US shale oil production boom. Generally, there are some visible pattern changes in all variables since 2020 following the Corona virus outbreak. The slump in oil prices after production shutdowns in the industrialized economies is particularly notable and so is the renminbi's gain vis-à-vis the US dollar.

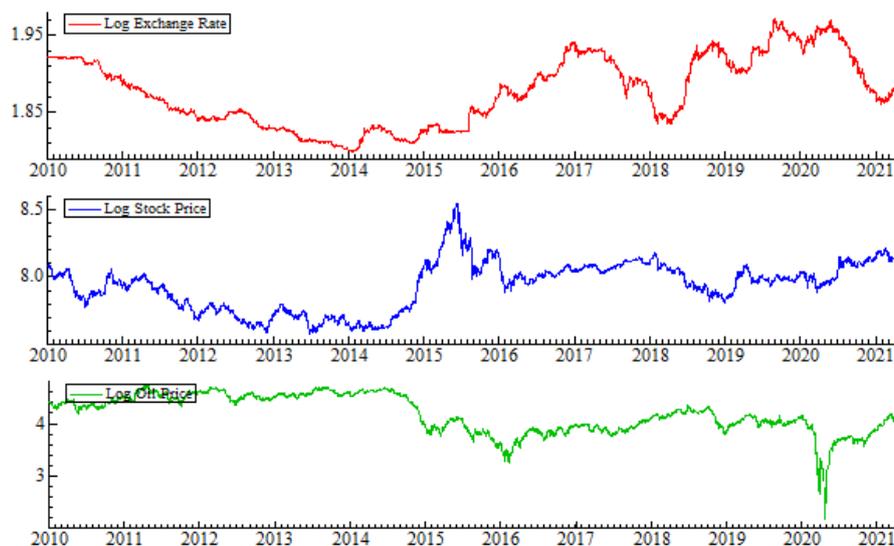


Figure 1. Time plot of variables

Unit root tests were performed on the tables using the augmented Dicky-Fuller (ADF) and Phillips-Perron tests and the test results are summarized in Table 2. According to the ADF test results, log exchange rate and log stock price are not stationary at levels whereas, log oil price is levels-stationary. This results are replicated by the PP test results. The conclusion for both set of tests confirm that both dependent variables (exchange rate and stock prices) are I(1) series whereas the independent variable (oil price) is an I(0) series.

Table 2. Unit Root Test results

Series	Levels	Difference	Stationarity
<i>Augmented Dickey-Fuller</i>			
Log Exchange Rate	-1.46(0.84)	-24.69(0.00)	I(1)
Log Stock Price	-2.67(0.25)	-20.88(0.00)	I(1)
Log Oil Price	-5.81(0.00)	-23.58(0.00)	I(0)
<i>Phillips-Perron</i>			
Log Exchange Rate	-2.05(0.59)	-42.65(0.00)	I(1)
Log Stock Price	-3.61(0.03)	-43.31(0.00)	I(0)
Log Oil Price	-4.32(0.00)	-58.09(0.00)	I(0)

Note. p-values of test statistics in parentheses.

A visual inspection of log exchange rate and log stock price in Figure 1 suggests that the time paths of both series could have been altered significantly following some exogenous events. If these shifts in the time paths of the variables are not accounted for, there is tendency for errors to occur in explaining their long-run manifestations. To circumvent such errors, we apply the Bai and Perron (BP, 2003) test that accommodates up to 5 breaks. The result of the sequential L+1 versus L breaks is summarized in Table 3 along with the estimated break dates. According to the results, both variables experienced 4 structural breaks during the analysis period. The break dates for both series are also strikingly similar which is not surprising given that both series are exposed to the same macroeconomic shocks.

Table 3. Bai-Perron structural break test results

Hypothesized Breaks	F-Statistics		Critical F.
	<i>Log Exchange Rate</i>	<i>Log Stock Price</i>	
0 not 1	2512.32	3429.97	8.58
1 not 2	2699.72	3481.009	10.13
2 not 3	365.22	344.193	11.14
3 not 4	138.04	28.73925	11.83
4 not 5	0.000	0.000	12.25
<i>Estimated Break Dates</i>			
	13/09/2011	09/09/2011	
	02/12/2014	22/09/2014	
	08/08/2016	27/05/2016	
	30/05/2018	19/07/2018	

3.2 Asymmetric Impact of Oil Price on Exchange Rate and Stock Price

In order to examine how oil price affects exchange rate, we implement the NARDL model for both series. We estimate two models in each case, one that accounts for structural breaks and one that doesn't. Table 4 summarizes the models with structural breaks for both variables. The coefficients and t-statistics are shown in both instances. At a glance, we see that oil price does not significantly influence both markets in the long-run as neither of the long-run coefficients are significant in both cases. We also observe that oil price's long-run impact on exchange rate is positive but its long-run impact on stock price is negative. While these estimates are not statistically significant, they do follow the theoretical predictions in part. Being a net oil consumer, China's currency should depreciate vis-à-vis the US dollar due to loss in competitiveness resulting from higher export costs when oil price increases. Similarly, a higher oil price implies greater production costs which decreases expected profits and firms' stocks. Turning to the short-run estimates, an oil price increase or decrease reduce exchange rate but increase stock price. These results partly run contrary to theory in both cases since we expect an oil price increase to depreciate the RMB and decrease stock price and an oil price decrease to appreciate the Renminbi and increase oil price. On the contrary, the results show that exchange rate would appreciate for a short-run oil price change whether positive or negative and that stock price would rise regardless of whether oil price rises or decreases. The bounds tests confirm significant cointegration in both models despite the insignificant long-run estimates. Concerning asymmetry, the evidence shows that oil price's effect on exchange rate differs between positive and negative oil price changes. But this difference is mainly in magnitude terms since the coefficients of positive and negative oil price changes have the same signs. The same pattern is observed for the short-run asymmetry test in the exchange rate model. In the stock price model, there is no evidence that oil price has an asymmetric impact whether in the short- or long-run.

Table 4. Estimated NARDL equations with breaks

Variables	Log Exchange Rate			Log Stock Price	
	<i>Coefficient.</i>		<i>t-Statistic</i>	<i>Coefficient.</i>	<i>t-Statistic</i>
<i>Long-run</i>					
	op^+	0.066	0.519	-0.012	-0.085
	op^-	0.083	0.637	-0.014	-0.096
<i>Short-run</i>					
	$\Delta ex(-1)$	-0.037	-2.003**	—	—
	Δop^+	-0.007	-3.036***	0.039	2.643***
	$\Delta op^+(-1)$	—	—	0.037	2.471**
	Δop^-	-0.005	-3.293***	0.036	3.213***
	$\Delta op^-(-1)$	-0.007	-4.146***	0.044	3.493***
	$\Delta op^-(-2)$	0.0002	0.146	0.023	1.899*
	$\Delta op^-(-3)$	-0.005	-2.867***	—	—
	$ECT(-1)$	-0.004	-5.127***	-0.012	-4.806***
Breaks	Yes			Yes	
Bounds F	6.565***			5.767***	
Long-run asymmetry F	5.579**			1.744	
Short-run asymmetry F	10.567***			0.971	
B-G LM test	0.146			2.193	
B-P test	130.95***			266.176***	
RESET	0.754			0.144	
CUSUM	Stable			Unstable	
CUSUM Squares	Stable			Stable	

Note. B-G LM is Breusch-Godfrey LM autocorrelation test. B-P test is Breusch-Pagan heteroskedasticity test. HAC standard errors used.

*, **, & *** respectively mean significance at 10%, 5%, & 1%.

In Table 4, the estimated NARDL models without breaks have been reported. The results are strikingly similar to the previous results with breaks. For instance, oil price's long-run impact on exchange rate and stock price is positive and negative respectively regardless of oil price's change direction. In addition, oil price's effect in both models is insignificant at the 5% level. Again, the long-run results obtained in Table 5 are partly in line with the theoretical expectations although insignificant at acceptable levels. Expectedly, when oil price increases, exchange rate would depreciate and stock price would decrease, but insignificantly in the long-run. The short-run estimates suggest that exchange rate would appreciate and stock price would rise significantly regardless of what happens to oil price as found in Table 4. Table 5 results differ from the previous result in that the bounds test found no evidence cointegration in both models. Also, an evidence of asymmetry in oil price's effect is lacking in both long-run models but present in both short-run models. Given that the oil price's coefficient for negative and positive changes in both short-run models have the same signs, the short-run asymmetry is in terms of magnitude and sign direction.

Table 5. Estimated NARDL equations without breaks

Variables	Log Exchange Rate		Log Stock Price		
	<i>Coefficient.</i>	<i>t-Statistic</i>	<i>Coefficient.</i>	<i>t-Statistic</i>	
<i>Long-run</i>					
	op^+	0.015	0.135	-0.449	-1.783*
	op^-	0.012	0.106	-0.449	-1.847*
<i>Short-run</i>					
	$\Delta ex(-1) \text{ or } \Delta sp(-1)$	-0.028	-1.503	-0.027	-1.481
	$\Delta ex(-2)$	0.002	0.110	—	—
	$\Delta ex(-3)$	0.038	2.069**	—	—
	Δop^+	-0.007	-3.596***	0.035	2.349**
	$\Delta op^+(-1)$	—	—	0.035	2.414**
	Δop^-	-0.005	-3.175***	0.037	3.393***
	$\Delta op^-(-1)$	-0.007	-4.041***	0.046	3.763***
	$\Delta op^-(-2)$	-0.001	0.399	0.025	2.071**
	$\Delta op^-(-3)$	-0.004	-2.619***	—	—
	$ECT(-1)$	-0.002	-2.672***	-0.006	-3.374***

Breaks	No	No
Bounds F	1.782	2.844
Long-run asymmetry F	0.922	0.043
Short-run asymmetry F	6.348***	5.877**
B-G LM test	0.388	0.508
B-P test	114.402***	143.56***
RESET	1.999	0.649
CUSUM	Stable	Stable
CUSUM Squares	Unstable	Unstable

Note. B-G LM is Breusch-Godfrey LM autocorrelation test. B-P test is Breusch-Pagan heteroskedasticity test. HAC standard errors used. *, **, & *** respectively mean significance at 10%, 5%, & 1%.

4. Conclusion

China has emerged as one of the biggest energy consumers in the world. The country's crude oil consumption is estimated to be nearly one-third of OECD countries and is projected to rise to 18 million barrels per day by 2040. On the basis of China's heavy energy-dependence, we analyse the role of crude oil prices movements on the country's exchange rate and stock markets using daily data. More importantly, we examined possibility of asymmetries in the impact of oil price on both markets using asymmetric ARDL approach. In addition, China's economy has witnessed several key structural events that when ignored, could adversely affect the result of our analysis. Hence, we account for structural breaks in testing for asymmetric oil price effects on both markets. The results suggest that oil price influences the exchange rate and stock price in China mainly in the short-run when daily data is used. These results are consistent whether or not we account for structural breaks in the methodology. However, evidence of cointegration only exists when structural breaks are included in the model which confirms that the structural events significantly alter the time paths of the US dollar-Renminbi rate and Shanghai index from their usual time paths over the analysis period. Evidence of short-run and long-run asymmetry is found for exchange rate when structural breaks are included whereas only short-run asymmetry persists when there are no breaks. For stock price, there is evidence of short-run asymmetry only when there are no structural breaks in the model. In general, our findings show that oil price appreciates the Renminbi significantly vis-à-vis the US dollar whether or not oil price increases or decreases in the short-run. Similarly, there is a short-run increase in the Shanghai index whether or not oil price increases or decreases. In light of these findings, the observed asymmetries in the influence of oil price on both variables are in magnitude terms only and do not relate to direction of impact. The main takeaway these results in terms of policy is that oil price seems to influence both markets mostly in the short-run and hence, short-term policies that affect both should fully consider oil-price's role.

Author Contributions

Ahmed, N.: Conceptualization, Resources, Validation, Writing – original draft, Formal analysis and Methodology. **Dingchou, M.:** Investigation, Project administration, Supervision. **Qayyum A.:** Data correction, Writing – Review & Editing.

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Declaration of interests

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