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Asymmetric and nonlinear pass-through of global crude oil price to China's PPI and CPI inflation

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ABSTRACT

With China's expanding import demand of crude oil and the gradually relaxing regulation of domestic oil prices, the global oil price is likely to affect China's price level more closely. Based on an augmented Phillips curve framework, this article employs both the autoregressive distribution lag (ARDL) and nonlinear and asymmetric autoregressive distribution lag (NARDL) model to investigate pass-through effects of crude oil price on China's producer prices index (PPI) and consumer prices index (CPI) in China. It is found that the impact of global oil price fluctuations to China's PPI and CPI are asymmetrical in the long-run, and the long-term impacts of the rise in global oil prices on PPI and CPI are greater than the global oil price decline on PPI and CPI. However, the symmetric ARDL model fails to diagnose the impact of oil price to China's PPI and CPI. Therefore, it is necessary to consider asymmetric relationship in the study of global oil price's influence on China's domestic prices.

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1. Introduction

The fluctuations of oil prices are exogenous shocks to the economy, and oil price changes are directly related to the production cost of the product, which affects the changing price levels. It is widely accepted that oil price shocks at least partially pass through into inflation (Chen, 2009). With the gap of self-supply and consumption demand of crude oil continues to expand, China is increasingly dependent on imports of oil. In 2012, China's crude oil import was as high as 0.27 billion tonnes, and dependency on imported oil was increased to 56.4%. As one of the most important resource inputs, the fluctuations of global oil prices are likely to have considerable impact on China's manufacturing costs, which affects the production producer prices index (PPI) and the consumer prices index (CPI). Moreover, the link between global crude oil prices and domestic oil prices become stronger. Petroleum price regulations in China gradually relaxed and market-orientated oil pricing mechanisms have been confirmed since 1998. In November 2001, China's refined oil price adjustments

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refer to the average prices of three markets, Singapore, Rotterdam and New York, which strengthen the synchronisation between global crude oil prices and domestic oil prices. Since the beginning of 2009, the refined oil pricing mechanism has been further reformed, and the domestic refined oil prices began to be based on global crude oil prices, coupled with the domestic average processing costs, taxes and reasonable profits. Therefore, the trend of China's domestic oil prices following global oil prices is more obvious and global oil prices may greatly affect China's PPI and CPI too.

However, China's oil market is in an oligopoly situation, and the production, import and wholesale of oil are mainly controlled by three petroleum enterprises. Non-competitive market structures may cause asymmetric price transmission (Meyer & Cramon-Taubadel, 2004). When the global oil price rises, the importing costs of domestic petroleum enterprises also rise. In order to maintain a certain profit, domestic petroleum enterprises will enhance refined oils prices and to greater extent, will rely on monopoly power. The refined oils are inputs and the raw materials of a variety of industrial products, so production cost of various products will increase and push up PPI to a large extent. It will also increase living costs, because households consume substantial refined oil products, and thus push up CPI. However, when the global crude oil prices decline, in order to make more profit, domestic petroleum enterprises can lower the refined oil prices to a small extent because of their monopoly power. This means the decline of PPI and CPI is also smaller too. Thus, we can assume that the pass-through effect is asymmetric, and the magnitude of crude oil price pass-through to PPI and CPI is greater when crude oil prices rise, rather than when prices decline.

Therefore, it is meaningful to study the asymmetric transmission of crude oil prices to PPI and CPI in China. If the transmission is asymmetrical, people suffer a loss of welfare because of the monopolistic oil market. So, it is necessary to reduce China's oil industry's monopoly power. Moreover, it suggests that the authorities should carry out different strengths of monetary policies in response to global oil prices rise and fall. Our aim is to investigate asymmetric pass-through of global crude oil price to China's PPI and CPI inflation.

2. Literature review

Since the oil crisis in the 1970s, the pass-through effect of global oil price fluctuations on inflation has been receiving growing attention from many scholars and policymakers. Oil price pass-through effect refers to the influence of changing crude oil prices on domestic aggregate prices, including PPI and CPI.¹ Hamilton (1983) argues that, in 1960, all but one crude oil price increase lead to every recession after World War II. However, the degree of oil price pass-through from global oil prices to domestic prices has turned out to be inconclusive (Valcarcel & Wohar, 2013).

Extensive research shows that global crude oil prices affect domestic inflation unambiguously. Barsky et al. (2002) reveal that oil price is obviously inflationary for output price. LeBlanc and Chinn (2004) estimate the transmission effects of oil price changes to inflation G5 countries and find that the oil price increases have moderate impacts on inflation in the US, Japan and Europe. Cunado and Pérez de Gracia (2005) adopt six Asian countries' data over the period 1975Q1–2002Q2 and verify that oil prices have significant effects on both economic activities and price indexes. Chou and Tseng (2011) find evidence a significant pass-through effect of oil prices on CPI inflation in emerging Asian countries

in the long-run. Chou and Lin (2013) verify that oil prices have important pass-through effects on Taiwan's producer price indices both in the short- and long-run. Sai and Ibrahim (2012) analyse the oil price pass-through into consumer price inflation for Malaysia. They find evidence for a long cointegration of oil prices with aggregate consumer prices and food price indexes. Ibrahim and Chanchaoenchai (2014) find the presence of long-run relations between oil prices and aggregate CPI using a cointegration modelling method with Thailand data.

In contrast, some research asserts that the impact of global oil prices on domestic inflation seem to be limited or declining. Hooker (2002) revealed that the impact of oil prices on US inflation were weakened when the sample was extended beyond 1981. Barsky and Kilian (2004) concluded that the consumer price inflations were not always related to oil price shocks in the US. Blanchard and Galí (2007) considered a set of industrialised economies and concluded that the inflationary impact of oil price shocks was consistently smaller over time. De Gregorio et al. (2007) examined 34 developed and developing countries by using quarterly data from 1965Q1 to 2005Q1, and found that the relationship between oil price and inflation was decreasing. Killian (2008) argued that the average exogenous oil price shock on inflation was quite small in G7 countries. Chen (2009) investigated the relationship between oil price and inflation using a state space approach and data from 19 industrialised countries, and found the declining pass-through phenomenon for almost all these countries. Álvarez, Hurtado, Sánchez, and Thomas (2011) used the Dynamic Stochastic General Equilibrium model for Spain and the eurozone, then noted that the inflationary impacts of oil price changes were limited. Shioji and Uchino (2011) confirmed the declining pass-through rate, both at the aggregate and sectoral levels for the period 1980–2000. Valcarcel and Wohar (2013) revealed the pass-through effect of oil prices on inflation has been negligible since the 1980s, using US quarterly data spanning 1948Q1 to 2011Q2.

However, the relationship of crude oil and inflation may be asymmetric and neglected by symmetric method (Hamilton, 2009, 2011; Valcarcel & Wohar, 2013). In fact, many studies confirm that the global crude oil prices' transmissions to domestic prices are asymmetric and nonlinear, and the extent of the influence of global crude oil prices rising and falling on domestic prices are different. Mork (1989) first examined and found the nonlinear and asymmetric responses of inflation to oil price increase and decline in the US. Hamilton and Herrera (2001) documented that there are nonlinear and asymmetric relationships between oil prices and US inflation. Du, Yanan, and Wei (2010) verified that the global oil price has significant effects on China's economic growth and inflation, and that the impact is nonlinear. Chou and Lin (2013) found the significant nonlinear error-correction relationships among the oil price, output and wages and producer prices in Taiwan.

But few studies focus on China's asymmetric relationship between oil price and inflation in the short- and long-term, let alone calculate asymmetrical transmission coefficients from global oil price to China's PPI and CPI. Therefore, this article serves to fill this gap by using the nonlinear and asymmetric autoregressive distribution lag (NARDL) model developed by Shin, Yu, and Greenwood-Nimmo (2013) to investigate the asymmetric transmission of the global oil price to China's major price indexes, PPI and CPI. To the best of our knowledge, this is the first attempt to employ NARDL to model global oil prices and China's domestic prices. In order to compare differences of asymmetric and symmetric transmission, the symmetric autoregressive distribution lag (ARDL) model will be used too. Because China's market-orientated oil pricing mechanism reform started in 1998, thus, domestic oil prices

and global oil prices have been more closely linked since then. Therefore, quarterly data from 1998 are selected for our research, and PPI and CPI are used as proxy for domestic prices.

3. Methodology

The Phillips curve is the most important tool to study the relationship of inflation and output gap. Many previous studies add global crude oil price variables to the framework of the Phillips curve, so as to study the influence of global crude oil prices on inflation (Chen, 2009; Chou & Lin, 2013; Cunado & Pérez de Gracia, 2005; Hooker, 2002; LeBlanc & Chinn, 2004). In this article, we also investigate global oil prices impact on China's PPI and CPI in the augmented Phillips curve framework. The general augmented Philips curve model with oil cost can be written as:

$$\pi_t = \beta(L)\pi_{t-i} + \gamma UG_t + \vartheta(L)o_t + \varepsilon_t \tag{1}$$

Where $\pi_t = p_t - p_{t-1} = \Delta p_t$ denotes inflation rate, p_t in the log of the PPI or the CPI; UG refers to the gap between unemployment rate and the nature unemployment rate; o_t presents the log of global crude oil price($\ln o_t$); L is the lag operator, ε_t is the iid error term. According to Okun's law, UG can be substituted with the output gap, so (1) can be represented as follows:

$$\pi_t = \beta(L)\pi_{t-i} + \gamma(y_t - \tilde{y}_t) + \vartheta(L)o_t + \varepsilon_t \tag{2}$$

Where y_t and \tilde{y}_t refer to output and potential output, so $(y_t - \tilde{y}_t)$ can denote output gap. y_t is the log of ouput(GDP) and \tilde{y}_t is the Hodrick–Prescott filtered trend of y_t . As π_t can be substituted with $(p_t - p_{t-1})$ in equation (2), model (2) can be rewritten as:

$$p_t = \beta'(L)p_{t-i} + \gamma(y_t - \tilde{y}_t) + \vartheta(L)o_t + \varepsilon_t \tag{3}$$

Therefore, a long-run equilibrium relationship may exist between: p_t , o_t and $(y_t - \tilde{y}_t)$ in equation (3). According to traditional cointegration theory (Engle, 1982; Engle & Granger, 1987), if variables are $I(1)$ and cointegrated, their dynamic relationships can be represented as an error correction model (ECM). While Pesaran and Shin (1999) argued that, as long as variables obeyed $I(0)$ or $I(1)$, variables may be cointegrated and can be presented as an ARDL model based on ECM. They also assert that ARDL is more effective to determine cointegrating relationships when samples are small. Therefore, if price level (p), oil prices(o) and output gap($y_t - \tilde{y}_t$) obeyed $I(0)$ or $I(1)$ and are cointegrated, we can consider an ECM based on ARDL (ARDL-ECM) as follows:

$$\pi_t = \Delta p = \mu + \rho p_{t-1} + \theta o_{t-1} + \sum_{i=1}^{m-1} \varphi_i \Delta p_{t-i} + \sum_{i=0}^{n-1} \tau_i \Delta o_{t-i} + \gamma(y_t - \tilde{y}_t) + \varepsilon_t \tag{4}$$

Where Δ Symbol denotes first-order differential operation, and it indicates the change of price level or oil price. Model (4) can express the relationship between price level and oil price in the short- and long-run. The long-run coefficient of oil prices pass-through to price level can be defined as: $L_{oil} = -\theta/\rho$. However, the rise and fall of global oil prices are likely to have asymmetric and nonlinear influences on price levels in both the short- and long-run (Chou & Lin, 2013; Du et al., 2010; Mork, 1989), so an asymmetric and nonlinear

model is necessary to investigate the nonlinear and asymmetric relationship between oil price and oil price level.

Shin et al. (2013) developed a NARDL which employs positive and negative partial sum decompositions to investigate the asymmetric relationship in both the short- and long-run. We adopt the NARDL model to analyse asymmetric pass-through effects of oil price to price levels, and get both positive Δo_t^+ and negative Δo_t^- partial sums by decomposition of o_t :

$$o_t^+ = \sum_{j=1}^t \Delta o_j^+ = \sum_{j=1}^t \max(\Delta o_j, 0) \tag{5}$$

$$o_t^- = \sum_{j=1}^t \Delta o_j^- = \sum_{j=1}^t \min(\Delta o_j, 0) \tag{6}$$

where o_t^+ and o_t^- are partial sum processes of positive and negative changes in o_t . Then, we introduce o_t^+ and o_t^- into symmetric ARDL(m, n) model (4) and the asymmetric ARDL(m, n) model presented as:

$$\begin{aligned} \pi_t = & \mu + \rho p_{t-1} + \theta^+ o_{t-1}^+ + \theta^- o_{t-1}^- + \sum_{i=1}^{m-1} \varphi_i \Delta p_{t-i} + \\ & \sum_{i=0}^{n-1} (\tau_{t-1}^+ \Delta o_{t-1}^+ + \tau_{t-1}^- \Delta o_{t-1}^-) + \gamma (y_t - \tilde{y}_t) + \varepsilon_t \end{aligned} \tag{7}$$

where m and n are lag orders for independent variables and dependent variables, respectively. We use the bounds-testing procedure suggested by Pesaran, Shin, and Smith (2001) to investigate the cointegration relationships between variables, the joint null of the modified F-test is, $\rho = \theta^+ = \theta^-$. L_{oil^+} and L_{oil^-} are long-run influence coefficients of oil price rising and falling pass through to price level, respectively, and they can be defined as $L_{oil^+} = -\theta^+/\rho$, and $L_{oil^-} = -\theta^-/\rho$. The long-run symmetry can be tested by a Wald test of the joint null hypothesis $-\theta^+/\rho = -\theta^-/\rho$. The short-run symmetry can be tested by a standard Wald test of the joint null hypothesis

$$\sum_{i=0}^{n-1} \tau_i^+ = \sum_{i=0}^{n-1} \tau_i^- \quad \text{for } i = 1, 2, \dots, n - 1.$$

If a short-run or a long-run (or both) asymmetry relationship is confirmed in the NARDL model, we can derive and trace the positive and negative cumulative dynamic multiplier effects of a unit change in o_t^+ and o_t^- on p_t , respectively.

$$m_h^+ = \sum_{j=0}^h \frac{\partial p_{t+j}}{\partial o_t^+}, \quad \text{and} \quad m_h^- = \sum_{j=0}^h \frac{\partial p_{t+j}}{\partial o_t^-}, \quad h = 0, 1, 2 \dots \tag{8}$$

When $h \rightarrow \infty$, then $m_h^+ \rightarrow L_{oil^+}$ and $m_h^- \rightarrow L_{oil^-}$. $L_{oil^+} = -\theta^+/\rho$, and $L_{oil^-} = -\theta^-/\rho$ are the positive and negative asymmetric long-run coefficients of oil price to price level, respectively, as defined previously.

4. Data and results

Quarterly data from 1998Q1 to 2014Q1 are used in the empirical analysis, all variables are seasonally adjusted and price variables of PPI, CPI and oil price are expressed in natural logarithms, $lnppi$, $lnpci$ and $lnoil$. The crude oil (petroleum) price is utilised as the proxy indicator of global crude oil price, and the unit is US dollars per barrel. The oil price data are obtained from IMF's International Financial Statistic (IFS) Database. CPI and PPI data are collected from the databases of BVD-EIU Country data, and both data of CPI and PPI are rebased to 2005=100. As mentioned before, y_t is the log of GDP seasonal adjusted by Census X-12 approach, and \tilde{y}_t is the Hodrick–Prescott filtered trend of y_t , so $(y_t - \tilde{y}_t)$ is the output gap.

Before regression, we apply the Augmented Dickey–Fuller (ADF) test, and Phillips–Perron (PP) test to investigate the stationary properties of the $lnppi$, $lnpci$, $(y_t - \tilde{y}_t)$, and $lnoil$. As shown in Table 1, we find that series of $lnppi$, $lnpci$ and $(y_t - \tilde{y}_t)$ are $I(1)$. However, variable $lnoil$ is $I(0)$ by ADF test, while $I(1)$ by PP test. Because of the extremely low power of the ADF test, we can consider $lnoil$ as $I(1)$ series, too. Therefore, we can construct ARDL and NARDL model to proceed cointegration tests and identify long-term equilibrium relationships.

We select PPI and CPI as the proxy variables of domestic price index (p), and estimate symmetric and asymmetric effects of crude oil price fluctuations on PPI and CPI with ARDL and NARDL model, respectively. The empirical results are shown in Table 2. First, we observe the estimation results of oil price pass-through effects on China's PPI. In the symmetric ARDL model, the F_{PSS} test is not significant statistically at the 5% level, and the long-run coefficient L_{oil} is not statistically significant either. This indicates that, in the symmetric transmission model, no cointegration relationship between global oil price and PPI exists, and that the influence of global oil price fluctuations on Chinese PPI is limited. However, F_{PSS} is significant at the 1% level when we consider the asymmetric effects of global oil prices on PPI in the NARDL model, which denotes a cointegration relationship between global oil prices and PPI exists. Both Coefficients of L_{oil^+} and L_{oil^-} are significant statistically at the 1% level, which indicate that increases and declines in global oil prices will bring significant influence to China's PPI. Specifically, a 100% rise in global oil prices

Table 1. ADF unit root and PP stationarity tests.

Variables	Levels		First-order difference	
	ADF	PP	ADF	PP
$lnppi$	-2.712	-2.537	-4.719***	-3.736**
$lnpci$	-2.932	-2.442	-4.317***	-4.499***
$lnoil$	-3.695**	-2.688	-5.974***	-5.219***
$(y_t - \tilde{y}_t)$	-2.808	-2.452	-6.839***	-6.860***

Notes: (1) The test equation includes both trend and intercept, and the optimal lags are determined using Schwarz information criterion and the maximum lags are 8; (2) p-values of ADF and PP test adopt MacKinnon's (1996) one-sided p-values; (3) ***, ** and * denote significance at the 1%, 5% and 10% level, respectively; and (4) The null hypothesis of both the ADF and PP test are the series have a unit root, If the null hypothesis is rejected, we can conclude that the series is stationary. Source: Calculated by the authors.



Table 2. Symmetric and asymmetric estimation results for crude oil prices pass-through to PPI and CPI.

OIL → PPI		OIL → CPI	
Symmetric ARDL		Symmetric ARDL	
	NARDL		NARDL
Inppi _{t-1}	-0.078*** (0.026)	Incpi _{t-1}	-0.022 (0.014)
Inoil _{t-1}	0.015 (0.005)	Inoil _{t-1}	0.007** (0.003)
ΔInppi _{t-1}	0.411*** (0.083)	Inoil _{t-1} ⁺	0.236* (0.126)
ΔInoil _{t-1}	0.069*** (0.007)	ΔIncpi _{t-1}	0.437*** (0.137)
(y _t - ŷ _t)	0.060 (0.046)	ΔIncpi _{t-2}	-0.410*** (0.104)
Constant	0.301*** (0.103)	ΔIncpi _{t-3}	0.019*** (0.005)
		ΔInoil _{t-2}	-0.016*** (0.005)
		ΔInoil _{t-2} ⁺	0.010 (0.039)
		(y _t - ŷ _t)	0.076 (0.056)
		Constant	
F _{pss}	5.10*	F _{pss}	3.88
L _{oil}	0.192	L _{oil}	0.318
		L _{oil} ⁺	
		L _{oil} ⁻	
		W _{LR}	
		W _{SR}	
Diagnostic Tests Statistics			
R ²	0.7843	R ²	0.6544
Adj-R ²	0.7654	Adj-R ²	0.6002
χ ₂ ²	0.704 [0.402]	χ ₂ ²	0.002 [0.966]
χ ₂ ^{HET}	0.40 [0.525]	χ ₂ ^{HET}	0.01 [0.921]
χ ₂ ^{Ramsey}	0.62 [0.607]	χ ₂ ^{Ramsey}	1.55 [0.215]
Cusum	stable	Cusum	stable

Notes: (1) ***, ** and * denote significance at 1%, 5% and 10% level, respectively; (2) maximum lag lengths of m and n are 5, and the general-to-specific approach is used to decide the final specifications by dropping all insignificant variables; (3) L_{oil}⁺ and L_{oil}⁻ refer to positive and negative long-run coefficients pass-through of oil price; (4) F_{pss} indicates the Pesaran-Shin-Smith F test statistic (Pesaran, Shin, & Smith, 2001), and following Shin et al. (2013), the conservative of critical values is adopted, k = 1, and the Upper bound test statistics at 10%, 5% and 1% are 4.78, 5.73 and 7.84, respectively; (5) χ₂², χ₂^{HET} and χ₂^{Ramsey} denote Breusch-Godfrey LM test for serial autocorrelation, Breusch-Pagan test for heteroskedasticity, and Ramsey RESET test, respectively; (6) W_{LR} refers to the Wald test for long and short-run symmetry, the relevant joint null hypothesis is -θ' / ρ = -θ' / ρ' while W_{SR} refers to the Wald test of short-run symmetry and the relevant joint null hypothesis is ∑_{i=0}ⁿ⁻¹ τ_{i-1}; (7) p-values and Standard Error are displayed in Parentheses and brackets, respectively; and (8) CUSUM denote the CUSUM test for stability of parameters.
Source: Calculated by the authors.

will bring a 14.3% rise in domestic PPI, and a 100% decline in global oil prices can only cause 8.2% of China's PPI to fall, so the asymmetric effect is obvious. W_{SR} is only statistically significant at the 10% level, which shows that, in the short-run, the global oil price has only weak asymmetric effect on China's PPI.

According to the estimation results of ARDL and NARDL models, if we do not consider the asymmetric transmission from crude oil prices to PPI, the asymmetric effects of oil price on China's PPI may be neglected in the long-run. The R^2 of estimation in NARDL model is greater than in ARDL model, which further indicates that estimation results by the NARDL model is better than by the ARDL model, so it is necessary to consider the asymmetric pass-through effects of global oil prices on China's PPI. In Diagnostic Tests Statistics, the Breusch–Godfrey Lagrange multiplier test and Breusch–Pagan test indicate that there are no serial autocorrelation and heteroskedasticity in the residuals. The Ramsey Regression Equation Specification Error Test and cumulative sum (CUSUM) tests show that model sets are appropriate and coefficients estimated are stable.

We investigate the effects of global oil prices on China's CPI. In the estimate of the symmetric ARDL model, F_{PSS} is not significant statistically, which means that no long-term stable relationship between global oil prices and China's CPI exists. However, in the NARDL model, F_{PSS} test is statistically significant at the 5% level, and this means that if the asymmetric transition effects of global oil price on China's CPI is taken into account, there is a long-run equilibrium relationship between global oil prices and China's CPI. W_{LR} is significant statistically at the 1% level, and it denotes the asymmetric effect of global oil prices on the Chinese CPI is remarkable. The long-run coefficient of global oil prices increase impacts on China's CPI, L_{oil+} is 0.143, and is significant at the 1% level statistically, indicating that a 100% rise in global oil prices will bring a 14.3% rise to China's CPI in the long-run. However, L_{oil-} is not significant in statistics, and it denotes that the decline effect of global oil prices to the Chinese CPI is limited. W_{SR} is not significant statistically, so the asymmetric effects of global oil prices to CPI is not significant in the short-term in China. Similarly, the R^2 of the NARDL model is greater than that of the ARDL model, which indicates that the estimation result of the NARDL model is better than the ARDL model, and that it is necessary to consider the asymmetry impact of global oil price to CPI. In diagnostic tests statistics, we can find that there exists no serial autocorrelation and heteroskedasticity in the residuals, so models sets are good, and coefficient estimates are stable. Therefore, the estimation results of these models are reasonable and credible.

Finally, we trace paths of asymmetric effects of global oil prices rise and fall to China's PPI and CPI by cumulative dynamic multiplier effects graph. And the bootstrap 95% confidence intervals (CI) for asymmetry are estimated too.²

Figure 1 plots the cumulative effect of $\ln PPI$ to $\ln oil$ (the left graph) and cumulative effect of $\ln CPI$ to $\ln oil$ (the right graph), and the longest period is selected to 40 period. The initial 1 unit of global oil prices increase will make China's PPI rise sharply in the short-term, and reach the maximum level of 18% in the fifth period, and then PPI will decrease gradually and reach the stable level of 14.3% in the tenth period. While the initial 1 units of the drop in oil prices will make China's PPI decline rapidly in the short-run, and reach the minimum level of -10% in the third period, the PPI will increase gradually, and reach the stable value of -8.2% in the tenth period. That is to say, the cumulative effect of global oil prices on China's PPI is roughly 10 periods in the long-run. The asymmetric effect of global oil price on China's PPI is quite obvious, and the global oil prices increase

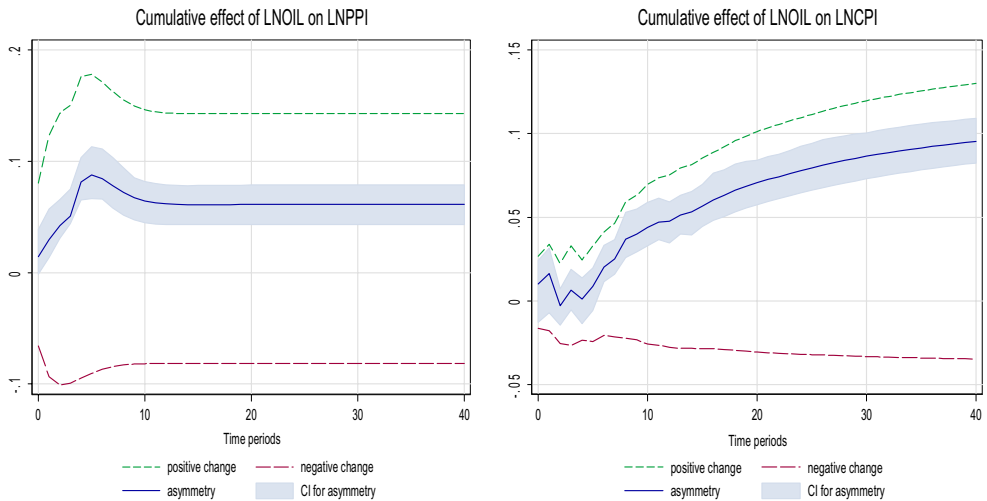


Figure 1. Asymmetric cumulative effect of oil price to China's PPI and CPI. Source: Calculated by the authors.

on China's PPI is significantly greater than the decline effect of global oil price on PPI. The asymmetric effect of the price of oil on PPI reaches the maximum state in the eighth period, and then gradually declines, and eventually stagnates at a stable level of about 6.1%.

In the graph of the asymmetric cumulative effect of global oil on China's CPI (the right graph of Figure 1), the unit of positive innovation in global oil prices will make China's CPI swing up and down in the short-run, and then rise rapidly after fourth period, and ultimately achieve equilibrium at a level of 14.3%. However, unit decline in global oil prices will bring concussion effects on China's CPI fall in the short-run, and generate decline impacts on CPI from the sixth period, and finally reach a stable level of -3.6%. And the asymmetric effect of global oil price to China's CPI is very clear. After experiencing four periods of up and down shocks, the asymmetric effects increase dramatically after a long time, and finally reach a new steady state.

5. Conclusion

In this article, we investigate both the symmetrical and asymmetrical impacts of global oil prices on China's PPI and CPI using the ARDL-ECM and NARDL-ECM model in an augmented Phillips curve framework. The results show that effects of global oil prices on China's PPI and CPI are asymmetrical. When the asymmetrical impacts are not considered, there exists no long-term equilibrium relationship between global oil prices and China's price levels (PPI and CPI). While considering the asymmetrical impacts, there exists a stable long-term relationship between oil prices and China's PPI and CPI, respectively, which means that global oil price fluctuations do affect China's price levels in the long-run asymmetrically. Therefore, it is necessary to consider the asymmetric effect of oil price on China's domestic price levels, it also confirms the cointegrating relationship that exists between the positive and negative components of the underlying variables, an effect of 'hidden cointegration' (Granger & Yoon, 2002).

The impact of global oil prices increase on China's PPI or CPI is greater than the decline of oil prices on PPI or CPI, which confirms price transmission is asymmetric, a phenomenon referred to as 'rockets and feathers' (Bacon, 1991). At the same time, it shows that the rise in global oil prices will bring China's price level up significantly, while the decline in global oil price will generate smaller decline effects on China's price level, so the asymmetric effect is very obvious. There is no doubt that China faces an increase in import demand in global crude oil, and the relationship between China's prices and global crude oil prices become more closely linked because of market-orientated oil pricing mechanism reforms. However, the government still has a strong control effect on the oil price. Therefore, when global oil prices are rising, the authorities have the cost pressures to adjust domestic oil prices, so that the cost of production and living increase, and oil costs ultimately reflect on the PPI and the CPI. However, when the global oil prices are declining, and authorities and the domestic monopoly enterprises of crude oil imports have no incentive to lower domestic oil prices, the decline effects of global oil prices on domestic PPI and CPI are smaller.

With the increasing demand for imported crude oil being driven by China's rapid economic growth, and its market reform to reduce oil price controls, the global oil price movements will affect the Chinese price level change to a greater extent. Therefore, it is necessary to pay more attention to the changes of global crude oil prices when suppressing inflation and monitoring price level fluctuation. Impacts of global oil price increases and declines on China's PPI or CPI are different, so the government should adopt different intensity monetary policy efforts to deal with the rise and decline of global oil prices. Because of oil price controls and domestic oil giants' monopolies, the global oil price transmission on PPI and CPI is not smooth and asymmetrical, and will cause welfare loss to production enterprises and resident consumers. The government needs to further relax oil prices control, and reduces monopoly pricing power of the petroleum enterprises. In addition, the government should increase domestic oil exploration and petroleum reserves, find alternative sources of energy, and improve energy efficiency, so as to reduce global oil price impacts on China's price level fluctuation.

Notes

1. Although there is no consistent definition to oil price pass-through effect, most of literature related to this theme generally researches the extent of inflation changes caused by oil price fluctuation (Hamilton, 1983; Hamilton & Herrera, 2001; Barsky, Kilian, & Blanchard, 2002; Blanchard & Galí, 2007; De Gregorio, Landerretche, & Neilson, 2007; Chen, 2009; Chou & Lin, 2013; Ibrahim & Chanchaoenchai, 2014).
2. The cumulative dynamic multipliers are estimated by the ordinary least squares (OLS) method according to model (8). For technical details, see Shin, Y., Yu, B., & Greenwood-Nimmo, M. (2013).

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References

- Álvarez, L. J., Hurtado, S., Sánchez, I., & Thomas, C. (2011). The impact of oil price changes on Spanish and Euro area consumer price inflation. *Economic Modelling*, 28(1–2), 422–431.
- Bacon, R. W. (1991). Rockets and feathers: The asymmetric speed of adjustment of U.K. retail gasoline prices to cost changes. *Energy Economics*, 13(3), 211–218.
- Barsky, R. B., & Kilian, L. (2004). Oil and the macroeconomy since the 1970s. *Journal of Economic Perspectives*, 18(4), 115–134.
- Barsky, R., Kilian, L., & Blanchard, O. (2002). Comments on do we really know that oil caused the great stagnation? A monetary alternative. *NBER Macroeconomics Annual*, 16, 183–192.
- Blanchard, O. J., & Galí, J. (2007). *The macroeconomic effects of oil shocks: Why are the 2000s so different from the 1970s?*. Barcelona: Ssrn Electronic Journal.
- Chen, S. S. (2009). Oil price pass-through into inflation. *Energy Economics*, 31(1), 126–133.
- Chou, K. W., & Lin, P. C. (2013). Oil price shocks and producer prices in Taiwan: An application of non-linear error-correction models. *Journal of Chinese Economic and Business Studies*, 11(1), 59–72.
- Chou, K. W., & Tseng, Y. H. (2011). Pass-through of oil prices to CPI inflation in Taiwan. *International Research Journal of Finance & Economics*, 6(69), 73–83.
- Cunado, J., & Pérez de Gracia, F. (2005). Oil prices, economic activity and inflation: Evidence for some Asian countries. *The Quarterly Review of Economics and Finance*, 45(1), 65–83.
- De Gregorio, J., Landerretche, O., Neilson, C., (2007). Another pass-through bites the dust? Oil prices and inflation. Working Papers Central Bank of Chile, 417.
- Du, L., Yanan, H., & Wei, C. (2010). The relationship between oil price shocks and China's macroeconomy: An empirical analysis. *Energy Policy*, 38(8), 4142–4151.
- Engle, R. F. (1982). Autoregressive conditional heteroskedasticity with estimates of the variance of United Kingdom inflation. *Econometrica*, 50(4), 987–1007.
- Engle, R. F., & Granger, C. W. J. (1987). Cointegration and error correction: Representation, estimation and testing. *Econometrica*, 55 (2), 251–276.
- Granger, C. W., & Yoon, G. (2002). Hidden cointegration. U of California, Economics Working Paper, (2002-02).
- Hamilton, J. D. (1983). Oil and the macroeconomy since world war II. *Journal of Political Economy*, 91(2), 228–248.
- Hamilton, J. D. (2009). Understanding crude oil prices. *Energy Journal*, 30, 179–206.
- Hamilton, J. D. (2011). Nonlinearities and the macroeconomic effects of oil prices. *Macroeconomic Dynamics*, 15(s3), 364–378.
- Hamilton, J. D., & Herrera, A. M. (2001). Oil shocks and aggregate macroeconomic behavior: The role of monetary policy: A comment. *Journal of Money Credit & Banking*, 36:2(542498), 265–286.
- Hooker, M. A. (2002). Are oil shocks inflationary? asymmetric and nonlinear specification versus changes in regime. *Journal of Money, Credit, and Banking*, 34(2), 540–561.
- Ibrahim, M. H., & Chanchaoenchai, K. (2014). How inflationary are oil price hikes? A disaggregated look at Thailand using symmetric and asymmetric cointegration models. *Journal of the Asia Pacific Economy*, 19(3), 409–422(14).
- Killian, L. (2008). A comparison of the effects of exogenous oil supply shocks on output and inflation in the G7 countries. *Journal of the European Economic Association*, 6(1), 78–121.
- LeBlanc, M., & Chinn, M. D. (2004). Do high oil prices presage inflation? The evidence from G5 countries. *Business Economics*, 34, 38–48.

- Meyer, J., & Cramon-Taubadel, S. V. (2004). Asymmetric price transmission: A survey. *Journal of Agricultural Economics*, 55(3), 581–611.
- Mork, A. K. (1989). Oil and the macroeconomy when prices go up and down: An extension of Hamilton's results. *Journal of Political Economy*, 97(3), 740–744.
- Pesaran, M. H., & Shin, Y. (1999). An autoregressive distributed lag modeling approach to cointegration analysis. In S. Strom (Ed.), *Econometrics and economic theory in the 20th century: The Ragnar Frisch centennial symposium* (pp. 371–413). Cambridge: Cambridge University Press.
- Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, 16(3), 289–326.
- Sai, R., & Ibrahim, M. H. (2012). Disaggregated consumer prices and oil price pass-through: Evidence from Malaysia. *China Agricultural Economic Review*, 4(4), 514–529.
- Shin, Y., Yu, B., & Greenwood-Nimmo, M. (2013). Modelling asymmetric cointegration and dynamic multipliers in a nonlinear ardl framework. *Ssrn Electronic Journal*, 14, 281–314.
- Shioji, E., & Uchino, T. (2011). Pass-through of oil prices to Japanese domestic prices. Nber Working Papers.
- Valcarcel, V. J., & Wohar, M. E. (2013). Changes in the oil price-inflation pass-through. *Journal of Economics & Business*, 68(68), 24–42.