THE INFLUENCE OF OIL PRICE SHOCKS ON CHINA'S MACRO-ECONOMY: A PERSPECTIVE OF INTERNATIONAL TRADE

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Abstract

This paper is aimed at investigating and understanding the relationship between China's macro-economy and oil price from a new perspective--the international trade perspective. We find strong evidence to suggest that the increase of China's price level, resulting from oil price shocks, is statistically less than that of its main trade partners'. This helps us to understand the confused empirical results estimated within the SVAR framework. More specifically, SVAR results suggest that China's output level is positively correlated with the oil price. Positive correlation between China's output and oil price shocks presumably results from the drop in China's relative price induced by oil price shocks, which is inclined to stimulate China's goods and service exports.

JEL Classification: F41; Q43; Q48

Key Words: Oil Price Shocks; International Trade; China's Macro-Economy

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1. Introduction

China has enjoyed impressive economic growth and undergone spectacular economic transformations since introduction of profound economic reforms in 1978. At the same time, it is also increasingly dependent on oil resources. The International Energy Agency (IEA) documented in a research report that the oil demand of China would keep increasing in a foreseeable future, associated with its fast speed industrialization and urbanization. China first became an oil-import country in around 1992, which happens to be the time of Deng Xiaoping's Southern Tour and China's shift towards a fully-fledged market economy. According to Figure 1, since 1992, China's oil imports have steadily increased, and were even immune to the financial crisis of 2008. Moreover, Figure 1 shows that increasing oil imports to China have been accompanied by sharply rising oil price. Specifically, the oil price has gradually climbed since 1992, with a small drop during 1997-1999 possibly resulting from Asian financial crisis. It upsurges dramatically after 2002. Interestingly, this timing quite closely follows that of China's entry into the WTO. Although with a sharp decline during the financial crisis between 2008 and 2009, the price gained momentum and instantaneously rebounded back after that, more importantly, seemingly with a higher volatility. Unambiguously, the interactions between the world oil price and China's macro-economy should have been more significant than ever.

Apart from many distinguished characteristics (for instance, the pricing of oil being not completely decontrolled) from other economic entities, a salient feature of China's economy is that it relies heavily on international trade. To study and better understand the effects of oil price shocks on China's macro-economy, it is essential and helpful to put sufficient attention on the fact that China is a typical export-oriented country. Concretely, it ranks first in terms of the proportion of total trade to GDP, which peaked to 65.3% in 2006. According to the data from China's National Bureau of Statistics (NBS), the average proportion of total trade to GDP is as high as 46.5% during 1992-2013.

Figure 1. Net Oil Imports of China and World Oil Price

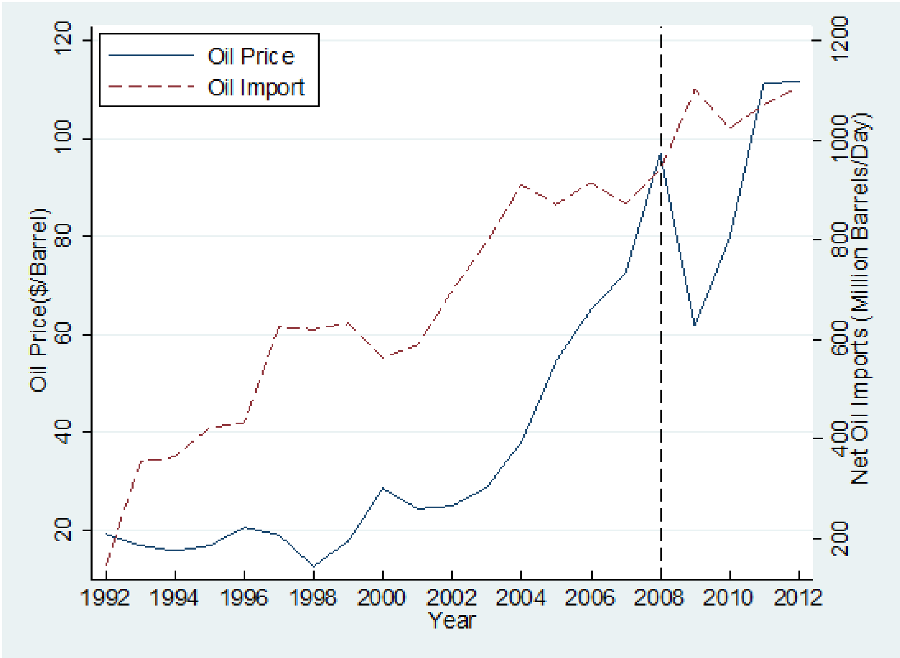
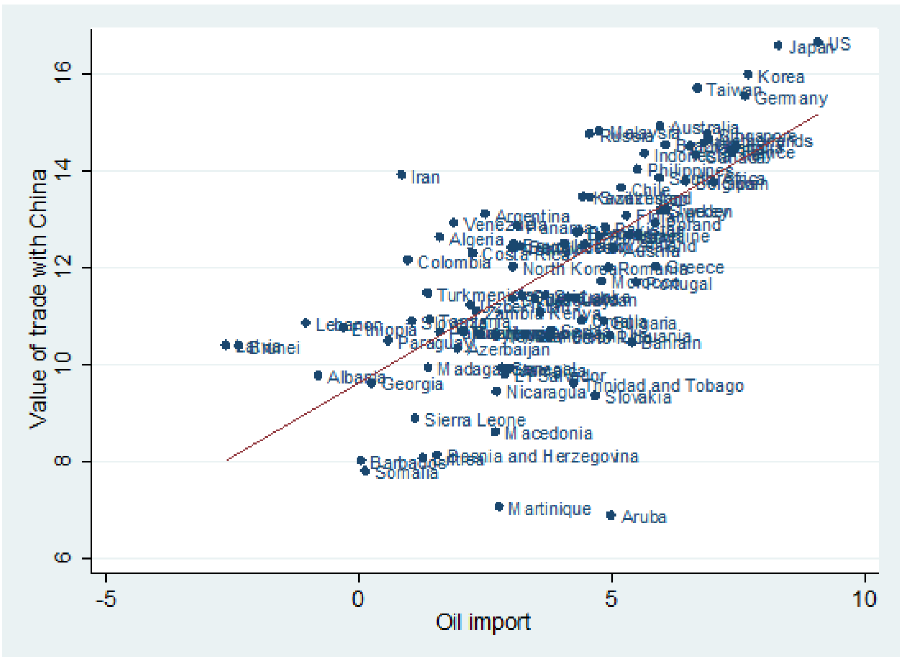


Figure 2 illustrates that the countries importing more oil are basically the ones that trade more with China, which implies that oil price shocks will influence China and its main trade partner simultaneously. The facts above show, on the one hand, that international trade is essential for China, on the other hand, that China's main trade partners are also major oil-dependent countries in the world. We have reason to believe that oil, as the most important bulk commodity in international trade today, will potentially change China and its partners' relative price level and further the goods and service exports of China or other relevant variables. This insight enlightens us to study and understand the effects of oil shocks on China estimated by econometric models from this new perspective, and accordingly distinguishes our paper from the existing literature.

Figure 2. Value of Trade with China and Oil Imports of Different Countries



Note: The oil import and value of trade with china is log scaled.

The remainder of the paper is organized as follows. In section 2, we review the literature related to our paper. The SVAR empirical results of oil price shocks are presented in section 3. In section 4, we give new interpretations for puzzling empirical results from SVAR estimation. Section 5 concludes.

2. Related Literature Review

The first oil crisis occurred in the 70s of the last century has spurred a large amount of literature which concentrates on the relationship between oil shocks and macro-economic activities. Nevertheless, considerable debates persist over the effects of oil price shocks in terms of both quantity and direction. Moreover, a variety of distinguished underlying transmission mechanisms have been proposed to rationalize the corresponding different empirical results.

Observing the fact that seven out of the eight postwar U.S. recessions have been preceded by a sharp increase in the price of crude petroleum, Hamilton (1983) concludes that oil shocks are a contributing factor in at least some of the US recessions prior to 1972. Hamilton (1996) proposes a measure of asymmetric oil price--net oil price increase, which is the maximum of zero and the differences between the level of the crude oil price in quarter t and the maximum value for the level achieved during the previous four quarters. The author draws a conclusion that supports his point in 1983 that real output of the US is negatively correlated with oil price shocks and the relationship is also statistically significant. A series of his following work (Hamilton, 2005; Hamilton, 2009 and Hamilton, 2010) reported similar results. Jimenez-Rodrigueza et al. (2005) confirm that the real GDP growth of oil importing economies suffers from increases in oil prices in both linear and non-linear models. Constructing large-scale macro-financial-econometric-model, Morana (2013) finds that oil market shocks have contributed to slow economic growth since the first Persian Gulf War episode. Lin and Mou (2008) explore the effects of oil price shocks on China within the framework of computational general equilibrium (CGE), and also present similar results. It is also the case for Zhang and Xu (2010). Le and Chang (2013) study the relationship between oil price shocks and trade imbalances, and find that for net oil importing economies, undesirable outcomes are associated with oil price shocks.

By contrast, other researchers have drawn different or even opposite conclusion. Bernanke et al. (1997) suggest that an important part of the effect of oil price shocks on the economy results is not from the change in oil price itself, but from the resulting tightening of monetary policy. Darrat et al. (1996) provide evidence to show that once the resulting interest rate increase is controlled, the effects of oil price shocks on the US economy will not be statistically significant any more. Barsky and Kilian (2004), argue that the effect is small and that oil shocks alone cannot explain the US stagflation of the 1970s. Blanchard and Gali (2007) present evidence showing that the dynamic effect of oil shocks has decreased considerably over time, owing to a combination of improvements in monetary policy, more flexible labor markets, and a smaller share of oil in production. Wong (2013) provides evidence to show that inflation pass-through from oil shocks in the 21st century relative to the 1970s has dampened. Establishing a five-variable VAR model Du et al. (2010) investigate the influences of oil price shocks on China's macro-economy. Their results show that China's output is positively correlated with oil price shocks, which is similar to our findings below. But our paper is different from Du et al. (2010) in both methodology and explanation.

Some researchers are committed to studying the underlying transmission mechanisms through which oil price shocks influence the macro-economy. Noticing that the empirical results are different, it is rather natural that the corresponding underlying transmission mechanisms used to interpret them are also dissimilar. In general, there are two different views on the relationship between oil price shocks and economic recession. One is they are statistically correlated to each other; the other is that this relationship is not significant or not clear.

According to Bernanke (1983), uncertainty will lead to a postponement of purchases for capital and durable goods, so the oil price shocks will influence the economy by increasing the uncertainty firms are confronted with. Rotemberg and Woodford (1996) suggest that the imperfect competition of the production market may better interpret the large negative effects of oil price shocks. Finn (2000) points out that in order to minimize depreciation expenses, when energy price changes, firms adjust capital utilization rates. Ramey and Vine (2010) argue that when the oil price rises, a shift in demand away from larger cars seems to have been a critical feature of the macroeconomic response to historical oil shocks. However, some other researchers argue that the relationship between oil price shocks and economic recession is not significant or not clear. Rogff (2006) elaborates that the effects of the oil shocks on the economy are generally weakened by technological advancements, improved energy efficiency, and the development of the financial market. As for the result that China's output is positively correlated with oil price shocks found by Du et al. (2010), the authors argue that this is presumably linked to that both China's growth and the world's oil price are affected by US and EU countries' economic activity in the same direction. Morana (2013) documents that as the negative impact on domestic demand may be mitigated by the increase of external demand (due to boosted imports of net oil export countries), the overall implications of the oil price drag mechanism are, however, not clear.

In summary, it can be stated that there is no consensus on empirical results about the effects of oil price shocks on the macro-economy and the transmission mechanisms through which the oil price shocks affect the macro-economy. Moreover, although a large amount literature has studied the transmission mechanisms, quite a few concentrate on the issue of China. Considering the reasons mentioned in section 1, we examine how international trade transmission mechanism works and investigate the effects of oil price shocks on China's macro-economy from this perspective. A related paper is Rasmussen and Roitman (2011). The authors argue that the negative impact of oil price shocks on oil-importing countries is partly offset by concurrent increases in exports and other income flows, and that these flows arise from high commodity prices being associated with good times for the world economy as well as from the recycling of petrodollars by oil-exporting. By contrast, we model these flows via a drop in China's relative price resulting from oil price shocks. Another related paper is Allegret et al. (2014), which investigate the effects of oil price shocks and their associated transmission channels on global imbalances. They find that along with oil price shocks, there is a transfer of wealth from oil-importing countries to oil-exporting ones. Our paper, however, proposes that this transfer can also happen (through the change of relative price induced by oil price shocks) among oil-import countries.

3. Empirical Results of SVAR

3.1 SVAR Model

In virtue of the work of Sims (1980), vector auto regression (VAR) has already become a widely used approach in macro-economy empirical analysis. Nevertheless, VAR is also constantly exposed to the criticism that it lacks economic interpretations. As Bernanke et al. (1997) indicates, it is not possible to infer the effects of changes in policy rules from a standard identified VAR system, since this approach typically provides little or no structural interpretation of coefficients that make up the lag structure of the model. By contrast, SVAR incorporates some structures or the economic theory into the analysis. Hence, we will investigate the effects of oil price shocks on China’s macro-economy within the framework of the SVAR in this paper. Formally, the SVAR system is formulated as:

$$A(I_K - A_1L - A_2L^2 - \cdots - A_pL^P)Y_t = Be_t \qquad (1)$$

Where A and B include the information that the economic theory implies and are $k \times 1$ matrices. L denotes lag operator, A_1, A_2 … A_p are $k \times k$ matrices, e_t is $k \times 1$ orthogonal disturbance term, that is, $e_t \sim N(0, I_K)$, and $\forall s \neq t$, $E(e_t e_s^{'}) = 0_K$. But what we can directly estimate is its reduced form:

$$Y_t = A_1Y_{t-1} + A_2Y_{t-2} + \cdots + A_pY_{t-p} + \mu_t \qquad (2)$$

In which μ_t is disturbance term and $\mu_t \sim N(0, \Sigma)$. Thus the relationship of the parameters in equation (1) and equation (2) can be written as:

$$\mu_t = A^{-1}Be_t \qquad \Sigma = A^{-1}B(A^{-1}B)^{'} \qquad (3)$$

By comparing the number of parameters between equation (1) and equation (2), we know that $(3k^2 - k)/2$ constraints are needed to identify equation (1), where k is the number of endogenous variables. In order to identify the model, we order the variables in the SVAR model as: oil price, real output, the price level, interest rate, money supply and exchange rate. That is, the oil price is prior to other macro-economy variables, signifying the oil price has a contemporary effects on other variables, but not the other way around; a reasonable assumption, since the oil price is primarily determined by the environment of the whole world but not a single country. Besides, we put all nominal variables after the real output. This is equivalent to assume that the real output has contemporary effects on them, but not the opposite; also, a weak assumption, since the commonly known time-lag influences of nominal and policy variables on real variables, which are indicated by the economic theory. Furthermore, we suppose the off-diagonal elements of the B matrix are all zero, meaning that the error terms of different times are not correlated. Considering that current variables are included in the system, this assumption is also not unreasonable. For now, combined with the normalization of the current variables' coefficients, the SVAR system above will be exactly identified.

3.2 Data

Monthly data spanning from 1994 to 2012 is conveyed to uncover the effects of oil price shocks on China's macro-economy. While we can easily explore the influences of oil price shocks on other macro-economic variables of relevance, we primarily focus on real output, general price level, money supply, interest rate and exchange rate on two grounds: First, they are most relevant to living standards and thus have received the closest attention from ordinary people. Second, in oil literature (Bernanke et al., 1997; Zhang and Xu, 2010; Du et al., 2010 and so on) these variables are also the most commonly studied, therefore, primarily focusing on these variables allows our results to be more comparable to the existing literature. In addition, what is worthy of attention is although we can, to some extent, control the effect of exchange rate by directly transforming the US dollar oil price to the RMB price (for example, Cong et al., 2008; Du et al., 2010), we explicitly incorporate the exchange rate into the variable system. This is quite natural and reasonable, especially recognizing the above-mentioned essential role of international trade in China.

For the reason that the National Bureau of Statistics of China (NBS) only publishes yearly and quarterly GDP data, following Zhang and Xu (2010), we use monthly industry output as the proxy of monthly output, and deflating them into real output. Consumer price index (CPI) is generally regarded as an appropriate proxy of the price level. CPI, compared to the same month in the previous year, available in NBS is used as the proxy of price level. It is widely known that the central bank frequently reacts to the fluctuations of the macro-economy. Therefore, variables that best capture the central bank's policy should be incorporated. Money supply is regularly regarded as the monetary policy instrument of the People's Bank of China. Taking the broadly recognized distinctions between M1 and M2 into account, instead of M2, we exploit M1 (obtained from the web-site of the People's Bank of China) to stand for monetary supply. In the view of the fact that the formation mechanism of interest rates is becoming increasingly market-oriented, interest rates are also incorporated into our system, which may, potentially, further capture the monetary policy. It is measured by the 6-month short-term loan interest rate derived from the arithmetic mean of the daily data, and, again, obtained from the web-site of the People's Bank of China. As for exchange rates and oil prices, we get them from the OECD and IEA databases, respectively. The statistics of the variables above are shown in Table 1.

Table 1. Definition and Statistics of Variables

Variables	Definition	Mean	S.D.error	Minimum	Maximum
OilP ($/Barrel)	*Oil Price*	43.86	30.94	9.82	132.70
ER(RMB/$)	*Exchange Rate*	7.90	0.66	6.30	8.71
M1(Billion RMB)	*Money Supply*	9504.5	7493.6	1543.5	28984.7
IR (%)	*Interest Rate*	7.06	2.17	5.31	12.06
Y(Billion RMB)	*Output*	2069.4	1999.3	299.2	7757.4
PL (%)	*Price Level*	4.31	6.34	-2.20	27.70

Note: We have normalized price level by subtracting 100.

3.3 Nonlinear Test

The SVAR model above is based on linear specifications. Therefore, they cannot capture asymmetric relationships between macroeconomic variables, which is noticed by Mork (1989), Lee et al. (1995), Balke et al. (2002), Hamilton (1996, 2003), Kilian and Vigfusson (2009), Carlton (2010), Ravazzolo and Rothman (2010) and Herrera et al. (2010) and so on. Before estimating the model, it is useful and necessary to carry out asymmetric tests of the oil price's effects on other variables. Define OP_t as the log difference of oil price. Following Mork (1989), we separate the oil price into positive and negative ones: $OP_t^+ = \max\{0, \mathrm{OP}_t\}$, $OP_t^- = \min\{0, \mathrm{OP}_t\}$. Along the lines of Hamilton (2003), we run OLS as follows:

$$V_t = c + \sum_{i=1}^{p} \alpha_i V_{t-i} + \sum_{i=1}^{p} \beta_i OP_{t-i} + \sum_{i=1}^{p} \gamma_i OP_{t-i}^{\#} + \varepsilon_t \qquad (4)$$

In which

$$V_t \in \{real\ output,\ price\ level,\ interest\ rate,\ money\ supply,\ exchange\ rate\}$$

and is in log difference form, $OP_{t-i}^{\#} \in \{OP_{t-i}^+, OP_{t-i}^-\}$. The null hypothesis is that the oil price has no asymmetry effects on other variables, meaning $\gamma_1 = \gamma_2 = \cdots = \gamma_p = 0$.

The asymmetry test results based on equation (4) are reported in Table 2. While we can report the lags chosen by certain criterion, we instead present all lags of interest. This is motivated by the combined observations that the lag lengths chosen based on different criteria are not consistent and the criterion values of different lags are quite close. It can be claimed from the results that the null hypothesis couldn’t be rejected in most cases, which in turn signifies that the linear symmetric model provides a good approximation in modeling the responses to oil price shocks (Kilian and Vigfusson, 2011), and increases the credibility of our model specification.

Table 2. Asymmetry Tests

	Output	*Price Level*	*Interest Rate*	*Money Supply*	*Exchange Rate*
1-Lag	0.4885	0.0418**	0.0129**	0.7656	0.7188
	(0.48)	(4.22)	(6.29)	(0.09)	(0.13)
2-Lags	0.6985	0.1287**	0.0235**	0.9229	0.5657
	(0.36)	(2.08)	(3.82)	(0.08)	(0.57)
3-Lags	0.3452	0.3643	0.0744*	0.8787	0.7055
	(1.11)	(1.07)	(2.34)	(0.23)	(0.47)
4-Lags	0.8074	0.3004	0.0916*	0.9759	0.4853
	(0.40)	(1.23)	(2.03)	(0.12)	(0.87)
5-Lags	0.9220	0.3065	0.1367	0.9381	0.4794
	(0.28)	(1.22)	(1.70)	(0.25)	(0.90)
6-Lags	0.9393	0.6717	0.2802	0.8076	0.6016
	(0.29)	(0.67)	(1.42)	(0.50)	(0.76)
7-Lags	0.9561	0.5333	0.2933	0.7773	0.7008
	(0.29)	(0.87)	(1.22)	(0.57)	(0.67)
8-Lags	0.7935	0.8620	0.4101	0.5028	0.7649
	(0.58)	(0.49)	(1.04)	(0.92)	(0.61)
9-Lags	0.8072	0.6534	0.5261	0.4356	0.8221
	(0.59)	(0.76)	(0.90)	(1.01)	(0.57)
10-Lags	0.8931	0.8605	0.5343	0.6990	0.8820
	(0.49)	(0.54)	(0.90)	(0.73)	(0.51)

Note: The numbers out and in parentheses are p-values and F statistics, respectively. Null hypothesis is that the world oil price has no asymmetry effects on the variables of interest. *** denotes significant at 1% level; ** denotes significant at 5% level; *denotes significant at 10% level.

3.4 SVAR Results

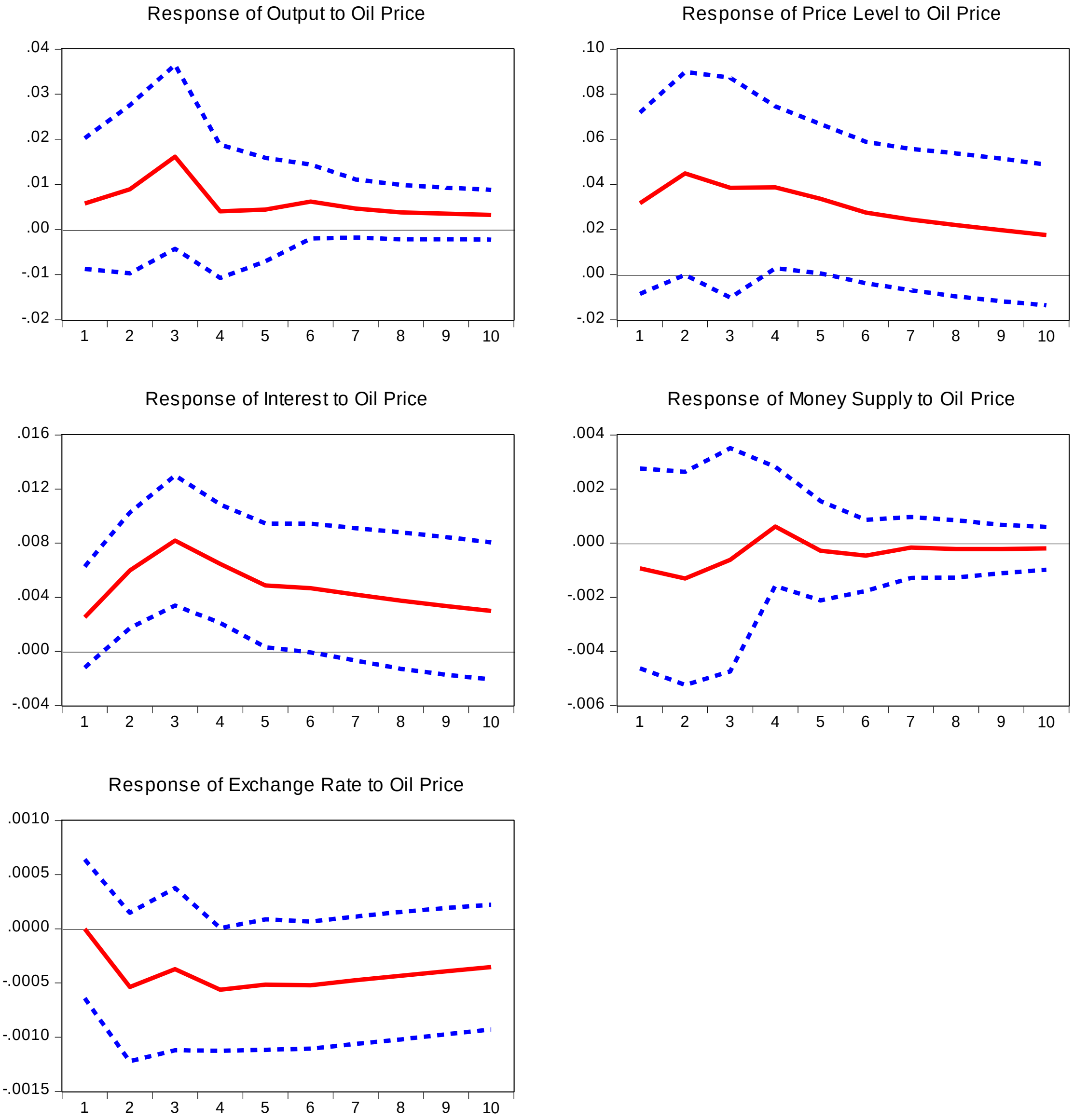
The lags of variables in SVAR model 2, as determined by AIC and FPE criteria. To satisfy stable conditions, the variables used in SVAR model are in log difference form. The response of main macro-economy variables to oil price shocks are presented in Figure (3). Figure 3 suggests that, except for the responses of output, our findings are quite intuitive and consistent with most of the existing literature. Specifically, the general price level of China rises in response to an increase in oil price. The rise in interest rates and decrease (although there is a small rise in period 4, it is not statistically significant) in money supply indicate the monetary policy tends to be tight in response to oil price shocks, showing the central bank's worry about inflation induced by oil price rising. Interestingly and notably, the response of interest rate is more persistent and quantitatively significant than that of money supply. This may reflect the swing in China's monetary policy instrument from giving priority to money quantity towards money price. Actually, Xia and Liao (2001) pointed out that money quantity is not appropriate to function as an intermediate target of monetary policy any more. Besides, it can be concluded from Figure 3 that oil price shocks slightly appreciate the RMB. A similar pattern is found by Huang & Guo (2007), which specializes in the study of the effects of oil price shocks on China's exchange rate, using a four variable VAR system.

For robustness reasons, the transformation of oil price is considered to allow for the measure of how unsettling an increase in the price of oil is likely to be for the spending decisions of consumers and firms, which is carefully studied by Hamilton (1996). Following literature, we exploit the transformation due to Hamilton (1996). The new “oil price” is titled as “Net Oil Price Increase” and is formally defined as:

$$NOPI_t^n = \max(0, \mathrm{OP}_t - \max(\mathrm{OP}_{t-1}, \mathrm{OP}_{t-2} \cdots \mathrm{OP}_{t-n})) \quad (5)$$

Where $NOPI$ denotes net oil price increase, OP stands for log difference oil price. Note that we have used log-difference of the variables in the SVAR analysis above, thus this transformation is used for log-difference oil price. The parameter n needs to be chosen, following Park and Ratti (2008) and Wang et al. (2013), n is set to be equal to 6.

Figure 3. Responses of Main Macro-economy Variables to Oil Price Shocks



Note: The dash line stands for 95% confidence interval.

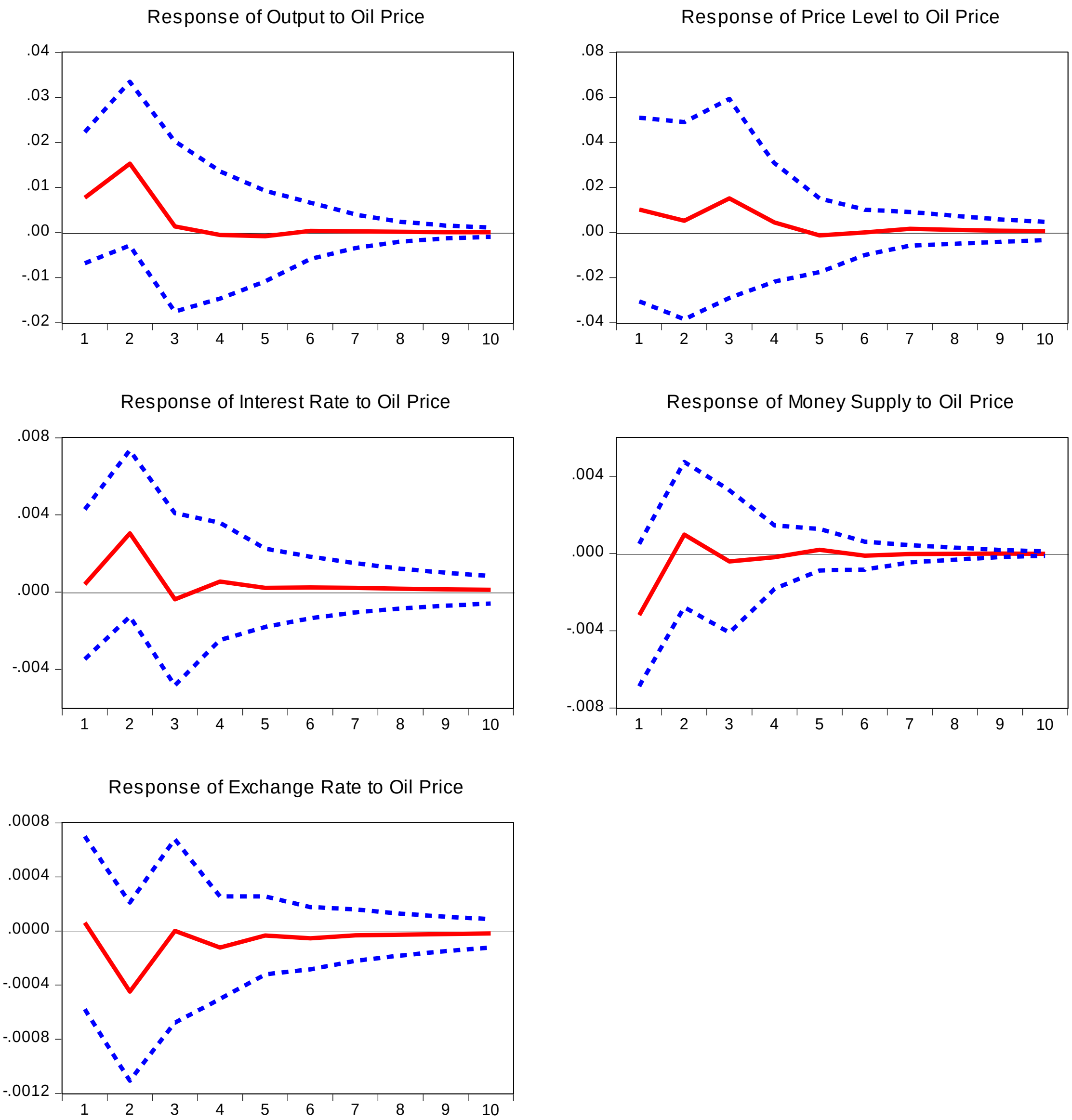
The SVAR model is re-estimated under the specification of Hamilton (1996), that is, the oil price is replaced by $NOPI$. The resulting impulse response functions are demonstrated in Figure (4). Though the results are quantitatively different from those illustrated in Figure 3, the response directions don't essentially change. Even if the differences between them in terms of quantity can also well be explained by recognizing that "Hamilton transformation" moderates the fluctuation of the oil price.

4. New Interpretations for SVAR Results

4.1 Basic Results

One puzzling result illustrated from Figure 3 and Figure 4 is that China's real output is positively correlated with oil price shocks. This finding is similar to that of Du et al. (2010) whose study period spans from 1995 to 2008. In their paper, by arguing that "…both China's growth and the world's oil price are affected by US and EU countries' economic activity in the same direction, and this in turn makes us observe … China's GDP and world's oil price is positively correlated from 1995 to 2008", the authors give a possible and preliminary interpretation for the real output of China is positively correlated with oil price shocks. But we want to go further and examine this puzzle not only from exogenous factors, but also from factors of China itself. Is there any mechanism that can interpret the puzzling results? According to section 1, while international trade is essential for China, China's main trade partners are also major oil-dependent countries in the world. Thus, there is no way to understand the puzzles above without paying attention to how oil price shocks influence China's trade condition. The most essential part of trade condition is relative price.

Figure 4. Responses of Main Macro-economy Variables to Oil Price Shocks (Hamilton Specifications)



Note: The dash line stands for 95% confidence interval.

If it is the case that there is a higher increase in the price level of China's main trade partners resulting from oil price shocks than that of China's, the abnormal phenomenon of the output's response to oil shocks will be well interpreted. This is because, relative to China, the higher increase of its main trade-partners' price levels resulting from oil price shocks will tend to stimulate China's exports and thus its output; To verify whether the increase of oil price lower China's relative price, we run the following regression for China and its main trade partners, respectively:

$$PL = \alpha_0 + \alpha_1 OilP + \boldsymbol{\alpha}_2 \mathbf{X} + \mu \qquad (6)$$

In which PL denotes the price levels, $OilP$ is the world oil price, and $\mathbf{X}$ is control variables including GDP growth rates, short-term interest rates, money supply growth rates and the exchange rates against the US dollar. The data used in equation (6) is from the OECD database, and the sample period spans from 1992:q1 to 2014:q2. As the GDP growth rate of China from 1992:q1 to 2010:q4 is missing in the OECD database, these missing values are calculated on the basis of the published data from NBS. World oil price data is from IEA. It should be noted that although, for China's data, we can use those from domestic databases, instead, instead we use the data from the OECD database, which enables our comparisons below more convincing, since due to different calculation methods or reference points, even the same variable from different databases will be diverse.

The regression results of equation (6) are presented in Table 3. For the record, since world oil price is same for all the countries, fix effect estimation cannot be implemented. The results in Table 3 provide substantial support to the point that the effects of oil price on China's price level and those of its major trade partners' are asymmetric, or more concretely, the oil price rise is intended to increase the price level of China's major trade partners more than that of China, China's relative price drops accordingly. These asymmetry effects are presumably correlated to the fact that oil pricing is not completely liberalized in China. Specifically, the oil price in China is to some extent regulated by the government, and thus oil price shocks will be inclined to have less influence on China's price level.

Table 3. Oil Price’s Effects on Price Level

	China	Main Trade Partner		
	OLS	POLS	RE	BE
Model (1)	0.342***	0.391***	0.391***	0.392***
	(0.023)	(0.018)	(0.020)	(0.020)
Model (2)	0.054	0.347***	0.347***	0.383***
	(0.054)	(0.015)	(0.015)	(0.016)
Model (3)	0.077**	0.048***	0.347***	0.375***
	(0.038)	(0.009)	(0.015)	(0.012)
Model (4)	0.048***	0.195***	0.201***	0.168***
	(0.009)	(0.008)	(0.008)	(0.011)
Model (5)	0.058***	0.184***	0.187***	0.148***
	(0.009)	(0.007)	(0.007)	(0.010)

Note: The number in brackets is standard error; ***, **, * stand for 1%, 5% and 10% significant level, respectively. Model (1) represents the case that no variables are controlled; In Model (2), the growth rate of money supply is controlled; In Model (3), the growth rate of money supply and exchange rate are controlled; In Model (4), the growth rate of money supply, exchange rate and interest rate are controlled; Apart from the previous control variables, output growth rate is also controlled in Model (5). P-OLS denotes pooled OLS; RE means random effect; BE stands for between estimators.

Increased oil price volatility probably affects the price level, since increased uncertainty presumably influences firms’ investment decisions (Bernanke, 1983; Pindyck, 1991), which in turn are closely linked to price level. The world oil price volatility itself is of relevance and emphasized by many authors (for example, Merton, 1980; Anderson et al., 2003; Park and Ratti (2008) and Pinno and Serletis, 2013). While oil price volatility may affect the price level, it is of course related with oil price. Omitting oil price volatility in equation (6) probably induces endogeneity problem. For robustness, oil price volatility needs to be included in the regression model. Before doing this, the oil price volatility needs to be calculated. In the paper of Merton (1980), Anderson et al. (2003) and Park and Ratti (2008), the measure of monthly oil price volatility is defined as the sum of squared first log differences in a daily spot oil price:

$$VOL_t = \sum_{i=1}^{n_t} \frac{(\log(p_t^{d+1}) - \log(p_t^d))^2}{n_t} \quad (7)$$

In which n_t denotes the number of trading days in month t. Since trading days in different months are not the same, it is not appropriate to simply replace n_t with 30. p_t^d is the spot oil price in day d of month t.

China is a transition country. According to the data from U.S. Energy Information Administration, its oil imports in 2012 are 15.8 times as many as those in 1993. Obviously, the oil price volatility in 1993 is different from that in 2012. In view of this distinguished characteristic of China, a new measure of oil price volatility is introduced in this paper, which is intended to capture the transition features of China. What we do is weight the measure of Merton (1980), Anderson et al. (2003) and Park and Ratti (2008) by the ratio of oil import to output. Formally, it can be formulated as:

$$WVOL_t = \frac{E_t}{Y_t} \sum_{i=1}^{n_t} \frac{(\log(p_t^{d+1}) - \log(p_t^d))^2}{n_t} \quad (8)$$

Where $WVOL$ is weighted oil price volatility, E denotes oil imports and Y is output, the remainder notations possess the same meanings as the ones in equation (7). The results that weighted oil price volatility is included in regression are reported in Table 4. Although oil price volatility is included, it is still the case that there is a higher increase in the price level of China's main trade partners resulting from oil price shocks than that of China.

Table 4. Oil Price's Effects on Price Level (Oil Price Volatility is Included)

	China	Main Trade Partner		
	OLS	POLS	RE	BE
Model (1)	0.280***	0.401***	0.402***	0.402***
	(0.017)	(0.008)	(0.021)	(0.021)
Model (2)	0.069**	0.368***	0.370***	0.413***
	(0.035)	(0.008)	(0.021)	(0.027)
Model (3)	0.061*	0.370***	0.372***	0.357***
	(0.033)	(0.008)	(0.014)	(0.019)
Model (4)	0.052***	0.262***	0.271***	0.223***
	(0.009)	(0.005)	(0.001)	(0.017)
Model (5)	0.059***	0.250***	0.258***	0.212***
	(0.009)	(0.005)	(0.007)	(0.011)

Note: The number in brackets is standard error; ***, **, * stand for 1%, 5% and 10% significant level, respectively. Except for that additional independent variable oil price volatility is included, the independent variables of Model (1)-Model (5) are the same as those in Table 3.

4.2 Robustness Check

It is known that China has surpassed Japan and became the second largest oil-importer since 2008. Therefore, the economic conditions of China will more likely influence the world oil price. To alleviate endogeneity problem resulting from the interaction of world oil price and China's economic conditions, instead of using current period oil price, one period lag oil price is included in equation (6). Since one period lag oil price is predetermined, the feedback effects from the dependent variable *CPI* is thus shut down. The results are reported in Table 5. These results also indicates that the increase of China's price level, resulting from oil price shocks, is statistically less than that of its main trade partners', which means oil price increase is likely to lower China's relative price.

Table 5. Oil Price's Effects on Price Level (One Period Lag Oil Price)

	China	Main Trade Partner		
	OLS	POLS	RE	BE
Model (1)	0.345***	0.390***	0.390***	0.391***
	(0.023)	(0.018)	(0.020)	(0.020)
Model (2)	0.052	0.350***	0.350***	0.381***
	(0.053)	(0.016)	(0.016)	(0.017)
Model (3)	0.100**	0.351***	0.351***	0.371***
	(0.037)	(0.016)	(0.016)	(0.014)
Model (4)	0.049***	0.195***	0.197***	0.160***
	(0.010)	(0.007)	(0.008)	(0.009)
Model (5)	0.051***	0.183***	0.186***	0.146***
	(0.009)	(0.007)	(0.008)	(0.010)

Note: The number in brackets is standard error; ***, **, * stand for 1%, 5% and 10% significant level, respectively. The independent variables of Model (1)-Model (5) are the same as those in Table 3.

Another issue worthy being noticed is that the central government of China perhaps offsets the price level increase induced by oil price shocks through monetary policy operations. This means that the independent variables short-term interest rates and money supply growth rates in equation (6) will be affected by the dependent variable *CPI*. To resolve this problem, we use one period lag interest rates and one period lag money supply growth rates as the instrumental variables for interest rates and money supply growth rates, respectively. The IV estimation results in Table 6 still suggest that oil price increase is intended to lower China's relative price, which in turn signifies that the robustness of the results above.

Table 6. Oil Price's Effects on Price Level (IV)

	China	Main Trade Partner		
	OLS	POLS	RE	BE
Model (1)	0.342***	0.3910***	0.391***	0.392***
	(0.023)	(0.018)	(0.020)	(0.020)
Model (2)	0.053	0.326***	0.343***	0.378***
	(0.053)	(0.016)	(0.015)	(0.0160)
Model (3)	0.076**	0.326***	0.343***	0.372***
	(0.037)	(0.016)	(0.015)	(0.012)
Model (4)	0.047***	0.192***	0.202***	0.168***
	(0.009)	(0.008)	(0.008)	(0.011)
Model (5)	0.058***	0.183***	0.198***	0.148***
	(0.008)	(0.008)	(0.007)	(0.010)

Note: The number in brackets is standard error; ***, **, * stand for 1%, 5% and 10% significant level, respectively. The independent variables of Model (1)-Model (5) are the same as those in Table 3.

5. Conclusion

International trade has played a significant role in China over the last 20 years. In this paper we examined the influences of oil price shocks on China from this new perspective. We find that world oil price shocks have a positive relationship with both China's real output and price level. This paper interprets this puzzling result form a new perspective. We argue that the asymmetry effects (perhaps resulted from the fact that the oil pricing is to some extent regulated by the government in China) of oil price shocks on China and its major trade partners maybe an important factor in accounting for the "abnormal" response of output to oil price shocks. This is because the higher increase of its main trade-partners' price levels resulting from oil price shocks will tend to stimulate China's exports and thus its output.

Our paper also has significant policy implications. We have found that both the real output and price levels of China are positively correlated with oil price shocks. Imagine that, confronted with an oil price increase, the authority mistakenly considers the output is, just as many papers imply, negatively correlated with oil price shocks, and take steps to stimulate the economy. This may lead to a second round increase in both the real output and the price level, the economy will consequently be liable to get overheated. Now consider another case that the authority wants to offset the inflation induced by oil price increases. If it believes that the output negatively responds to oil price increases, worrying about further recession in output caused by tight policy, the authority will be inclined to compromise its original target and take modest measures to offset the inflation induced by the oil price increase. Our results, however, imply that a relatively severe measure may be a better choice in this case.

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