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Impact of international crude oil price volatility on China's macro-economy

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ABSTRACT

In recent years, the great volatility of international oil prices has caused a serious impact on the smooth running China's economy. After the opening up of crude oil wholesale and retail markets, China's oil prices and world oil prices are more closely linked to each others. This paper aims at exploring the different influences on China's macro-economy after the opening up of crude oil wholesale and retail markets. To that end, a structured vector auto regression (SVAR) model was established. The results show that: the opening up of the crude wholesale and retail market accelerates the conduction of the international crude oil price volatility on China's economy; world oil price rise leads to a larger domestic output decline and this effect has a strong continuity; tightening monetary policy implemented by the government, such as reducing the money supply or raising interest rates, to some extent alleviates the pressure of inflation, but there is still the risk of excessive imposing. With the increasing dependence on foreign oil, the government must take measures to cope with the impact of international crude oil prices on our economy.

KEYWORDS

Transmission mechanism; Macroeconomic; Impulse response.

INTRODUCTION

Oil, as the "blood" of modern industry, plays a vital role in the economic development of a country or region. In 1970s and 1980s, the global economy suffered huge losses from two large-scale oil crises. The fluctuation of crude oil price affects the nerves of the world economy. Historical data show that almost every sharp fluctuation of oil prices will cause a global recession; Figure 1 clearly reflects this negative correlation. The frequency and amplitude of the fluctuations in international crude oil prices in 2007 far exceeded the expectations of the people. Although impact of Hurricane Katrina weakened, worrying U.S. crude oil inventories decreased coupled with Iran's geopolitical factors, the WTI crude oil prices quickly soared to 150 U.S. dollars/barrel. The outbreak of the global financial crisis ended the oil price bubble completely; the price of crude oil quickly fell to 35 U.S. dollars / barrel. With the implementation of the government economic aid policy, the world economy was gradually getting better, WTI crude oil prices bottomed out in January 2009 to $ 80 / barrel. European debt crisis broke in May 2010, the oil price was down to the level of the fourth quarter of 2009. Enter 2011, affected by the volatile situation in the Middle East, the Syrian war, the Iranian nuclear issue, the world crude oil price went into a higher position. World oil price experienced a trend of rise - fall -rise. On the contrary, the GDP growth rate went through the opposite trend.

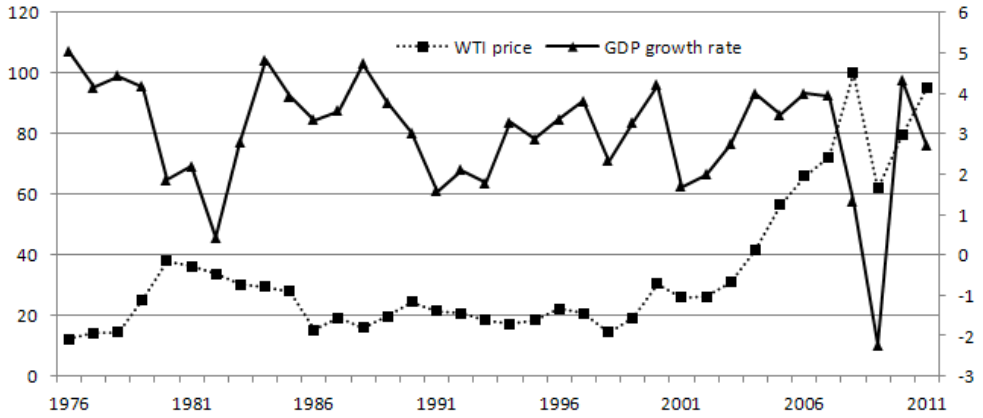

Figure 1 : Crude oil prices and the world economic growth

Data source: WTI crude oil prices from the EIA the U.S. Energy Department; World GDP growth rate from the World Bank database

With the continuous advance of China's rapid economic development and the process of industrialization, the demand for crude oil continued to rise. China is the world's fifth-largest oil-producing countries, but it is also the second largest consumer of oil, huge domestic crude oil consumption far exceeded their production limits (Figure 2). China's economic development is increasingly relying on crude oil imports, which is the root reason why China's crude oil import dependence is increasing year by year. In recent years, China's dependence on foreign oil is more than 50% of the international warning level, which means that China has more than half of its crude oil consumption from foreign imports while the previously mainly rely on domestic supply. There are serious gaps in our demand for crude oil, so that the sharp fluctuation of international crude oil prices has strong constraints on China's macroeconomic.

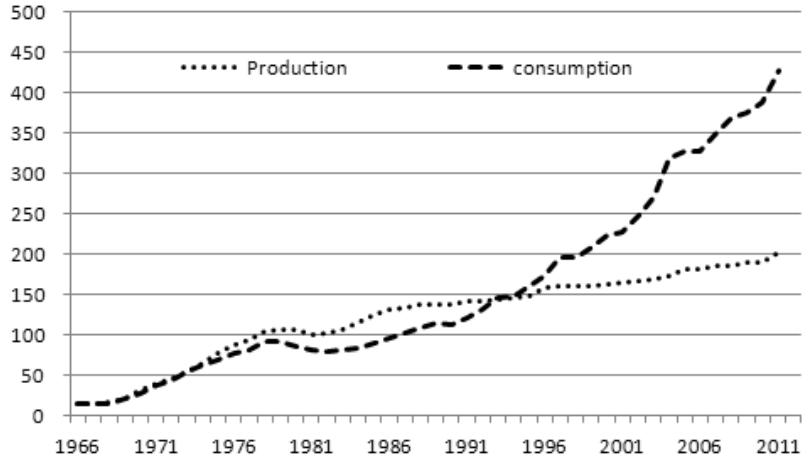

Figure 2 : Chinese crude oil production and consumption 1965-2010 (Unit: one million tons)

Source: statistical data of International Petroleum Economics and Gsmar database

In January, 2007, according to the agreement, China opened its oil wholesale franchise rights, the volatility of international crude oil prices has brought new uncertainties on China's economy. Despite former domestic scholars have conducted extensive research about international crude oil price fluctuations impact on China's macroeconomic, but as previously mentioned, the international and domestic crude oil market have undergone tremendous changes after 2007. Prior empirical results have not accurately reflected the action mechanism, so it is necessary to study this problem.

This study has a dual purpose: firstly starting with the relationship between China's output, inflation, money supply and interest rates and international crude oil prices, clarify the mechanism of the crude oil price volatility on China's macroeconomic; secondly through the establishment of SVAR model, the comparative analysis of the international crude oil price impact on China's economy generated before and after the opening up of the domestic crude oil market, put forward reasonable proposals for the new era of how to deal with the international crude oil price frequent fluctuation.

LITERATURE REVIEW

The two large-scale oil crises in 1970s and 1980s last century made world's major oil-consuming countries suffer severe recession, which greatly inspired scholars to research the relationship between crude oil price fluctuations and macroeconomic interactions. In earlier studies, Rasche and Tatom[12], Darby[5], Bruno and Sachs, and Hamilton[6] and other scholars confirmed crude oil prices and economic growth had a negative correlation, which Darby[5] and Hamilton[6] were more influential. Darby[5] examined the impact of oil price shocks on real income, the indirect effects of the introduction of export, exchange rates and money supply variables and found statistically significant negative correlation between the fluctuations in oil prices and the actual national income. Hamilton[6] used the VAR model to examine oil prices, GNP and unemployment data after World War II, including the second oil crisis. He found that the dramatic rise in oil prices after World War II (except in 1960) almost led to every recession and got the conclusion that international crude oil price volatility associated with negative real output activities in the United States.

Following studies gradually extended to other countries outside the United States, and supported the above view. Such as: Mork and Olsen[10] took the United States, Canada, Japan, Germany and other OECD countries as samples and the price was divided into up and down for asymmetry studies. At last, the conclusion that crude oil price and GNP had a negative correlation was established; Evangelia Papapetrou[11] using error correction model explorer the relationship between oil price fluctuations and stock market returns, interest rates and other economic activities from January 1984 to September 1999 in Greek, highly dependent on oil importing country. Research showed that oil price changes had a negative impact on industrial and can be well explained why the stock price changes.

International crude oil prices rose sharply since April 2007 because of tensions in the Middle East and gasoline inventories continued to decline of U.S. Western scholars carried a more in-depth exploration around the economic path of international oil price fluctuations and the mechanism. More representative of the study include: Segal[14] found that the rising oil prices affect the macro- economy through monetary channels from two aspects: the rising oil prices drove the overall price level to rise, resulting in the decrease in real money balances; indirectly led to higher interest rates, so that the real economy suffered a greater negative impact. Cologni and Manera[4] established SVAR model, with GDP, interest rates, consumer price index and money supply M2 from the United Kingdom, Germany, Italy and the other G7 countries, and the Brent crude oil price. Results showed that the GDP from the other developed countries expect Japan and the United Kingdom were inversely related to the international crude oil price and monetary variable. Anna Kormilitsina[1], by dynamic stochastic general equilibrium model (DSGE), did research in the influence of monetary policy to American macro-economy when oil price increased. Results indicated that monetary policy was the main reason for the U.S. economy recession. When oil price risen, the government should increase inflation rate and interest rate to alleviate the impact on the economy.

With the integration of China’s crude oil price into the world, the research on the influence of international crude oil price volatility to China's economic has drawn Chinese scholars' more and more attentions. In China, we discussed this issue broadly from both qualitative and quantitative aspects: analyze the trend of international crude oil prices, China's macroeconomic conduction and countermeasure through qualitative analysis: analyze the macro-economic impact on international crude oil price volatility with econometric model through quantitative analysis. Literatures for qualitative research are more extensive. For example, Zhijun Shen held that the current international crude oil price volatility was a result of changes in supply-demand relationship as well as international political and economic relations. From view of industry chain and balance of international payments, he studied the impact on domestic economy caused by the price volatility from the industry chain and the balance of international payments level impact. He also proposed to speed up the exploitation and utilization of substitutes for oil, and evade world market risk with the countermeasures such as futures hedging. From perspectives of increasing inflation, household consumption expenditure and relevant enterprises production costs as well as the deterioration of the external economic environment, Li Niu explored the effects on China’s macroeconomic from rising prices of international crude oil; Ruiyong Ma[16] made a summary of the conduction mechanism of domestic macro-economy influenced by international oil prices volatility. He summarized the mechanism including supply shock mechanism, income transfer mechanism, real balance mechanism, cost adjustment mechanism and anti-inflationary monetary policy mechanism. Empirical study makes quantitative analysis through the econometric models, such as VAR, IGEM, VEC, etc. Representative studies are as follows: Based on VAR econometric model, with linear and nonlinear methods, Wei Yu[15] found that impact of international crude oil price fluctuation on our macro-economic was asymmetrical and rising crude oil price was hindrance to economic growth with its hysteresis; Ruoen Ren established inter temporal

optimizing general equilibrium model with input-output time series data from 1981 to 2005. By this model, he explored international oil price volatility and substituted between other energy inject elements, including the impacts on national economy as well as its various departments. Results indicated that the international oil price had a certain effect on the overall output, output prices of the various departments and CPI. It also had the time-lag effect; Through introduction of purchasing managers index, Zhuo Li[17] established VEC model, with which he analyzed long-term and short-term dynamic relationships between fluctuation in international crude oil prices and macroeconomic variables, and proved that the hysteresis effect of international crude oil price volatility on China's macro-economy.

As mentioned above, the study of economic impact on fluctuation in international crude oil price has been more in-depth and wide-ranging, but deficiency still exists. For instance, to increase the length of the sample, some scholars do research with data from the year of 1998 and before. At that time, China's oil market did not integrate into the world, and the crude oil price was still dominated by the government. Thus, the sample has little reference value. As the wholesale and retail rights of domestic crude oil opened up formally in January 2007, there was more and more frequent interaction with the world crude oil market. WTI price fluctuations of U.S.A intensify due to economic crisis, European debt crisis and the unrest in the Middle East. With the gradual integration of China into the world crude oil market, the volatility is bound to cause a greater impact on China's economy. Therefore, it is necessary to re-explore the impact of the international crude oil price volatility on China's macro-economic, so that we can fill the vacancy in the research at home.

This paper is organized as follows: The first part represents analysis and comment of representative research findings on the impact of analyze the macro-economic influence of fluctuations in international crude oil prices at home and abroad, it also clarifies the foundation and opens the point of this study; The second part analyzes the conduction mechanism of fluctuations in international crude oil prices from a qualitative point of view, sorts out the relationship of fluctuation in oil prices and output, CPI, money supply and interest rates. It lays the theoretical foundation for the following empirical; With the establishment of the SVAR model with monthly data sample, the third part analyzes the dynamic characteristics and mechanism of action, which reflects the impact of international crude oil prices before and after the opening of oil market on China's four major macro-economic variables; The fourth part represents summary and conclusion.

CONDUCTION OF THE INTERNATIONAL CRUDE OIL PRICE VOLATILITY ON CHINA'S MACRO-ECONOMIC

The effect of crude oil prices on macro-economic subjects to China's pricing mechanism to a great extent. Before 1980, the crude oil price was under strict plan control. Low level of industrialization meant lower demand on crude oil, so this crude oil self-sufficiency could be realized, thus, fluctuations in international crude oil price could hardly affect our macro-economic. Reform on prices of the crude oil and refined oil was put in place in June 1998. It made a great reform to the pricing mechanism of crude oil and refined oil, stipulating domestic crude oil and refined oil prices should vary with the oil prices of Singapore market, thus, more and more links between domestic crude oil prices and the world price appear; From June 2000, China's refined oil price started to go with the world market, that is to say, domestic oil prices will vary with world market prices. By November 2001, integration mechanism of the domestic oil prices into the world market has been further improved, and domestic refined oil prices are set with the refined oil market prices in Singapore, Rotterdam and New York. With the constant improvement of integration mechanism, the conduction of international crude oil price volatility on China's macro-economic becomes more direct and rapid. Combined to the existing literatures and current domestic economic operation situation, the conduction of fluctuation in oil prices on domestic economy roughly come down to three ways below. (Figure 3)

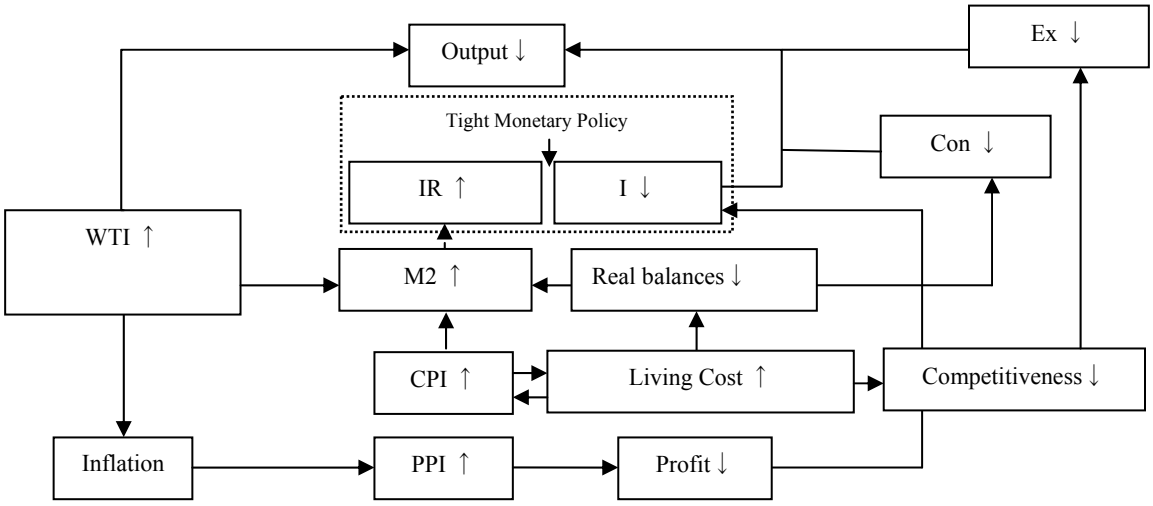

Figure 3 : Conduction mechanisms of the international crude oil price volatility

Conduction of output

International crude oil price has a direct impact on China's overall output in short term. According to International Energy Agency (IEA) "Agency-Economy development model", China's GDP will decline by 0.7% if international crude oil price rises at $10 per barrel. International crude oil price affects China's consumption, investment and exports, which are the "three carriages" to the development of the national economy, and makes a further impact on China's national economic output in the long-term.

From perspective of consumer, crude oil price rises, import cost increases, the cost of production with crude oil as raw material increases, and real income of resident reduces. Thus, the original demand will not be met and the output is bound to decline.

From perspective of investment, the rising international crude oil price increases the cost on production of the downstream industry chain, and industry profits falls, thus, greatly reduced the attractiveness to capital, and all of these lead to a decrease in investment and decline on output.

From perspective of export, higher crude oil price will definitely increase the cost of production and transportation of relevant industries, thus, China's export product no longer has its price advantage. In the international market of oversupply, competition is increasingly fierce. It is impossible for product price to keep pace with the cost of product, so the international competitiveness of export product declines, as well as export. As a result, output declines.

Conduction of CPI

As mentioned earlier, China's crude oil pricing mechanism has integrated into that of world, and the soaring international crude oil price will definitely leads to China's rising crude oil price. In terms of the relationship between international crude oil price, CPI and the current monetary policy, if the price of international crude oil rises at $10 per barrel, domestic CIP will be directly pulled around 0.5-0.8 percentage points higher. In consideration of dynamic and asynchronous impact of oil price on that of non-oil as well as the basic situation of current price of non-oil, the domestic CPI will increase by 1.5-2% overall, which will greatly exacerbated the pressure on domestic inflation. World crude oil price will broadly affect China's inflation by the following two ways: imported inflation through conduction of crude oil trade and cost-push inflation through conduction of industrial chain.

Through the above two ways, the international crude oil price rising bring domestic final consumer goods' price rising which will also react on wage and interest rate. Cost of product and living thereby increases, resulting in national inflation.

Conduction of Monetary Policy

By the preceding discussion, we can see that the impact of price of international crude oil acts directly on macroeconomic through itself, leading to inflation and economic recession. The shock can also cause changes of monetary policy and have an indirect effect on macro-economic.

The main goal of China's monetary policy is to stabilize commodity prices, to enhance economic growth, to achieve full employment and to strike a balance of international payments. Monetary policy adjusts macro-economic by money supply control. Fluctuations in international crude oil prices, thereby, affect the implementation of China's monetary policy by changing demand function for money. The two main ways of international crude oil prices affecting demand function for money are as follows:

One side, the rising international crude oil prices will increase the general price, and real balance will be reduced, thus, demand increases. Under the same condition of money supply, it will cause inflation. To prevent economy from overheating, government takes tight monetary policy raising interest rates, exacerbated economic recession further.

The other side, the government to ease increasing costs and reducing realized income by oil price shock, the government will take a loose monetary policy to stabilize output in the short term; but in the long run, due to the pressure from domestic inflation, government will have to constantly increase interest rate. Macro-economic will therefore suffer a greater negative impact in the long term.

DATA AND METHODOLOGY

Data description

From previous analysis, we can see that fluctuations in international crude oil prices will first lead to a direct decline in output by supply shock effect in short term, and caused inflation by cost of production increases. Then, it will affect real balance through income transfer effect. To stabilize the production, government controls and adjusts it with money supply and interest rates through monetary policy, which will indirectly affect China's macroeconomic.

Therefore, we select international crude oil prices as exogenous variable and output, inflation rate, money supply and interest rate as endogenous variables to examine the impact of changes in the international crude oil price volatility on China's macroeconomic system. (TABLE 1) International and domestic crude oil market change a lot around 2007, so we studies from January 1999 to December 2006 and from January 2007 to February 2012. By comparative analysis, we provide effective theory support on how to deal with fluctuations in international oil prices under current situation in China.

World crude oil price index, which selects the U.S. West Texas Intermediate crude oil (WTI) price as world crude oil prices index. The United States is the largest crude oil importer and consumer in the world. With its global military and

economic capability, the impact on WTI international crude oil is much stronger than the other crude oil markets, and WTI crude oil has become the global benchmark of crude oil pricing. Selecting WTI crude oil prices can fully represent the trend of international crude oil market price. At the same time, it also helps to examine the impact of crude oil prices volatility on China's macro-economic after economic crisis since the United States is one of the countries who suffer a lot from the crisis.

Output indicator

With a fact that our government does not make monthly GDP data public and data availability, to reduce the errors caused by subsequent processing, we select growth rate of industrial added value indicators to represent the change in output. The facts based on are as follows: Industry is a main leading power for the growth of China's GDP. Increasing costs caused by higher world crude oil prices are bound to affect the profits and output value of industrial enterprises, and will cause changes in China's overall output.

Inflation indicator

Inflation, a monetary phenomenon, refers to currency depreciation caused by that the amount of currency in circulation is supplied more than actual needs in the real circulation. The rising prices are the most intuitive reflection. Although inflation and rising prices belong to different areas of economic, there are close links between them. As it were, inflation and rising prices are two different manifestations of the same problem. As the consumer price is the final price, which is formed after various links of the circulation of goods purchased by households, it can fully reflect the required amount of currency circulation of commodities. Therefore, consumer price index can fully reflect the inflation rate of the price index. At present, the countries all over the world mainly apply consumer price index, CPI to reflect the inflation from each country.

Money supply indicator regards broad money (M2) as indicator of money supply. M2, commonly referred to as the money supply, equals to a total amount of currency in circulation plus current deposits, dated deposits and savings deposits. It can accurately measure the change of total social demand as well as future inflation pressures. In 1996, the People's Bank of China officially views money supply as the intermediate target of monetary policy in China, M2 for observation. In a word, it'll give the best reflection on China's monetary policy to regards M2 as money supply indicator.

Interest rate indicator: We select 7-day interbank rate, which is a short-term lending rate between different banks. The two main reasons below make us choose interbank offered rate as interest rate index: On the one hand, China has canceled upper limit on the interbank offered rate since June 1, 1996, which Implements the interbank lending market interest rate marketed. At present, inter-bank market is the only market which can realize interest rate liberalization except for China's political financial bonds market and national debts issuance market; On the other hand, theoretically, inter-bank market, with its short duration and large financial flow, is the one which is the most susceptible to changes of monetary policy tools. All in all, the 7-day interbank rate can give us the best reflection on interest rates of the same period in China.

TABLE 1 : Variable name, processing mode and source

Variable	Meaning	X12 adjustment	Log	Differential	Data Resource
OIL(O/N)	Oil price		√	√	EIA
Y(O/N)	output				China monthly economic indicators
CPI(O/N)	Inflation			√	People's Bank of China
M2(O/N)	Money Supply	√	√	√	Wind database
IR(O/N)	Interest Rate			√	People's Bank of China

Note: O refers to the data indicators before 2007; N represents data indicators after 2007, the same below

Model identification

As mentioned earlier, fluctuations in the international crude oil price not only have an effect on domestic inflation in the current period; it can also cause a change of national monetary policy and affect output in the long run. Characterizing dynamic characteristics through simple data only without consideration of economic significance between variables will make it difficult to distinguish endogenous variables from exogenous variables since there are few guidelines of the necessary economic theories. General form of VAR (p) model can be expressed as follows:

$$\mathbf{y}_t = \mathbf{C} + \mathbf{\Phi}_1 \mathbf{y}_{t-1} + \cdots + \mathbf{\Phi}_p \mathbf{y}_{t-p} + \boldsymbol{\varepsilon}_t \quad (1)$$

From the formula we can see that VAR model does not show the exact form of current correlation between variables, which is to say, it does not indicate current endogenous variables on the right of the model. However, these current relationships can not be explained since they are hid in the relevant structure of error term. Therefore, VAR model can not give us an accurate reflection on the impact of fluctuations in crude oil prices on the current output, inflation and other macroeconomic indicators.

In order to clarify the current interaction between variables, this paper introduces a structured vector autoregressive model (SVAR). The SVAR model, supported by economic theory, sets the interaction between current variables, which can avoid the hidden defects that can not be explained in the model error; By adding a small number of constraints to variables, SVAR model reduces the loss of the number of parameters to be estimated and model DOF, and to a great extent, it avoids the defect in result analysis of VAR model under unconstrained conditions. Therefore, it can better explain the dynamic impact of random perturbations (fluctuations in the price of crude oil) on System (China's macroeconomic) with its economic realities. The general form of SVAR (P) model with K variable can be expressed as follows:

$$A_0 y_t = \Gamma_1 y_{t-1} + \Gamma_2 y_{t-2} + \cdots + \Gamma_p y_{t-p} + u_t \quad (2)$$

$$A_0 = \begin{bmatrix} 1 & -a_{12} & \cdots & -a_{1k} \\ -a_{21} & 1 & \cdots & -a_{2k} \\ \vdots & \vdots & \ddots & \vdots \\ -a_{k1} & -a_{k2} & \cdots & 1 \end{bmatrix} \quad \Gamma_i = \begin{bmatrix} \gamma_{11}^{(i)} & \gamma_{12}^{(i)} & \cdots & \gamma_{1k}^{(i)} \\ \gamma_{21}^{(i)} & \gamma_{22}^{(i)} & \cdots & \gamma_{2k}^{(i)} \\ \vdots & \vdots & \ddots & \vdots \\ \gamma_{k1}^{(i)} & \gamma_{k2}^{(i)} & \cdots & \gamma_{kk}^{(i)} \end{bmatrix}, i = 1, 2, \cdots, p \quad u_t = \begin{bmatrix} u_{1t} \\ u_{2t} \\ \vdots \\ u_{kt} \end{bmatrix}$$

Formula 2 can be written with form of lag operator: $A(L)y_t = u_t, E(u_t u_t') = I_k$

Note: $A(L) = A_0 - \Gamma_1 L - \Gamma_2 L^2 - \ldots - \Gamma_p L^p$. A (L) is k×k parameter matrix of lag operator L, and A_0 is a matrix with 1 with the main diagonal elements, and $C_0 \neq I_k$

According to Cholesky's (Jolly Chomsky's) decomposition technique, endogenous variable in the forward position will have an impact on the value of the same period of the variables behind itself, but this is just an unidirectional action, which is to say, the latter will not affect the value of the same period of the former. Thereby, the selection of the order of SVAR model variables is of great importance. According to the previous definition, the variables are ordered as y_t= (oil, y, CPI, m2, ir), which represents international crude oil prices, output, CPI index, money supply and interest rate.

For SVAR model with K-variables-P-order, we must add k(k-1) / 2 boundary conditions to ensure the model's identifiability. In other words, we need to make zero constraints on ten short-term impact. In accordance with economic theory and literatures, the assumptions about structural effects between variables are as follows: According to Du's research (2010), international crude oil price has a significant influence on China's economy, while the changes of domestic economic activity are not Granger reasons for world crude oil price volatility. This is why international price of crude oil has strong exogeneity. It is itself that affects the price of international crude oil not gross domestic product, CPI, money supply and interest rate. The current output is just influenced by current price of international crude oil since it is difficult to pass to the overall output for inflation, national monetary policy and interest rate changes in the short term, which is to say, it has latency on output; In the short term, only international crude oil prices and output factors can produce an influence on inflation rate, while money supply and interest rates can only affect it through government changing monetary policy in the long term; international crude oil prices, output and current CPI can also affect M2, while interest rate has its latency; interest rates is a result of international crude oil prices, output, CPI and monetary supply.

The assumptions we made only applies to the current period, but it does not mean that the following variables have no effect on previous variables in the long term. According to the relationship of structure impact between the various variables, A_0 matrix can be set as follows:

$$\begin{bmatrix} \varepsilon_{wti} \\ \varepsilon_y \\ \varepsilon_{cpi} \\ \varepsilon_{m2} \\ \varepsilon_{ir} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 \end{bmatrix} \times \begin{bmatrix} \mu_{wti} \\ \mu_y \\ \mu_{cpi} \\ \mu_{m2} \\ \mu_{ir} \end{bmatrix}$$

1.Unit root tests To make sure if the selected variables have stationarity, we have unit root tests on two groups of time series through ADF test method, and the test results show as TABLE 2: The horizontal sequence of all variables passes the significance test of 1%, which means the variables have stationarity. Most of the economic variables tend to be unsteady, but we have made seasonal adjustment as well as differential during date processing. Therefore, we can omit co-integration test between variables when estimating VAR model.

TABLE 2 : Variables stationary test

Variable	t statistic	Threshold	Stationarity	Variable	t statistic	1% critical	Stationarity
oilo	-8.312316	-4.073859**	I(0)	oiln	-4.850819	-4.118444**	I(0)
yo	-8.453785	-4.090602**	I(0)	yn	-6.463083	-4.152511**	I(0)
cpio	-8.660081	-4.073859**	I(0)	cpin	-2.164171	-1.946549*	I(0)
m2o	-5.983414	-4.073859**	I(0)	m2n	-7.435305	-4.115684**	I(0)
iro	-8.968122	-4.073859**	I(0)	irn	-7.016113	-4.121303**	I(0)

2.Lag period selection Lag phase selection plays a very important role in estimating VAR model: the shorter of the lag period, the more serious autocorrelation of errors will there be, resulted in non-conformance estimate of the model parameters; If lag period is too long, though it can completely reflect the dynamic characteristics of the model, it will affect directly effectiveness of model parameter estimation, which is because the decrease of degree of freedom caused by the long lag phase. According to Schwarz (SC) and Akaike's Information Criterion (AIC), we marked the lag period of the model around market open-up as 2 and 3 on a basis of freedom of the model. Test results are omitted because of limited space.

3.Impulse Response Analysis Figure 3 shows the impulse response function of macroeconomic variables to the prices of international crude oil around market open-up.

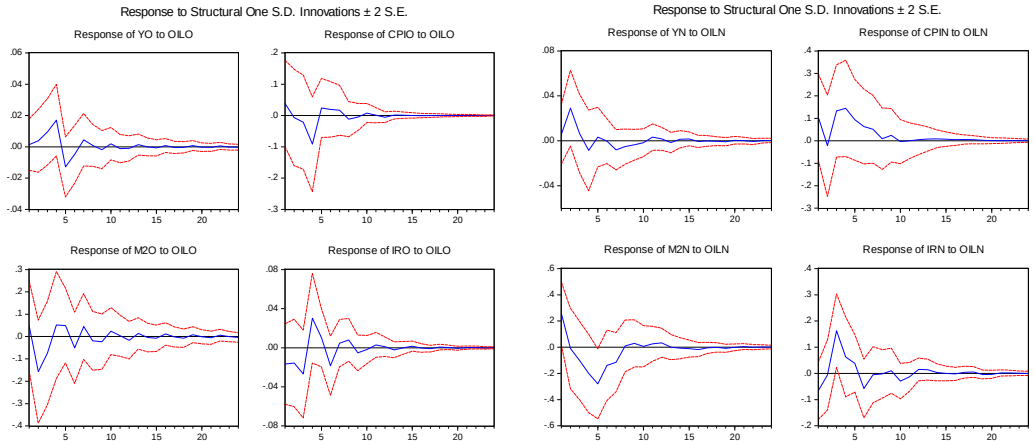

Figure 4 : Impulse response function of macroeconomic variables

Impact of international crude oil prices on output

It can be seen that WTI crude oil prices will make China's output decline whether before or after the reform, but obviously, this effect has its lag. The decrease of output caused by impact of international oil prices before opening up does not appear until the fourth period. After opening up, the lag period is shortened to two periods, which results in serious fall of China's output.

Before the market is completely open, the state's regulation on the price of crude oil, to some extent, did weaken the impact of international crude oil prices on China's overall output. The active demand for domestic economy also alleviates negative effects caused by rising prices of crude oil in recent years. However, noncommittally, the opening of market speeds up conduction of world crude oil market changes to China's macroeconomic, and lag period is shortened significantly. With the continuous progress of industrialization in China, the demands for crude oil and other high-quality energies increase day by day. Subject to production capacity on domestic crude oil, China has to import large quantities of crude oil to stabilize domestic production. The shock of international crude oil in the future will have more significant influence over China's economy due to the rising dependence on crude oil。

Impact on CPI of international crude oil prices

CPI had a rapid response to fluctuations in international crude oil prices around the opening of the market, so it had a significant positive influence in the current period. Before opening, the inflation caused by WTI crude oil prices was not so serious, and then gradually weakened, but it continued declining though it had been down to zero, which possibly caused by excessive policy response. With the opening up of the market, fluctuations in international crude oil price have more and more significant effect on the inflation in China, although the inflation had been down to zero during the second period, it rebounded and exceeded the initial level. Time of such positive effects was extended significantly, which indicates that the increasing cost of raw material and fuel caused by rising prices of international crude oil does exacerbate China's imported

inflation. With the development of economy and the improvement of people's living standards, the relationship between China's oil consumption and the residents' daily lives becomes increasingly closer.

The increasing share of auto consumption of entire GDP consumption accelerates the conduction of fluctuations in international crude oil price on CPI. It is noteworthy that China's current CPI weighted structural adjustment obviously falls behind changes of the residents' consumption structure, and daily use such as food, alcohol and tobacco, clothing, etc. account for nearly 50 percentages in residents' consumer price index, while oil and other resource consumption occupy little in CPI, which will possibly make the impact of world crude oil prices on CPI underestimated.

Impact on money supply of international crude oil prices

From the pulse response Figure of M2 to international crude oil price shock around the opening of market, we can see that government usually adopts tight monetary policy to deal with the inflation caused by the rising crude oil prices. At present, China is the second largest net importer of oil in the world, and crude oil import dependence has exceeded by 50%. The continuous rise of international crude oil prices will lead to increasing demand for domestic currency, which will cause relative decrease of money supply. In addition, central bank tends to increase interest rates and raise reserve against deposit to cope with the inflation caused by rising international oil prices, thus, money supply decreases further. Besides, government usually takes tight monetary policies in response to inflationary pressure caused by the rising international oil prices. Influenced by the dual effect, money supply of M2 shows a downward tendency.

Since fluctuation in international crude oil prices has little effect on China's inflation before the opening of the market, government usually adopts moderate monetary policies. Therefore, M2 declines little. With the deduction of inflation, M2 money supply shows varying degrees of rebound. After the opening of the market, in order to curb the continuous inflation caused by crude oil volatility, government devotes greater efforts to monetary policies, which decreases M2 as well as negative duration. Figures 3-7 and 3-6 show the impact of WTI crude oil price on inflation and M2 is substantially mirror related, which indicates that government plays an active role in curbing inflation by taking tight monetary policy.

Impact on interest rate of international crude oil prices

Interest rate is the main tool for government to take monetary policy. Time period is necessary during monetary policy's making, implementation as well as its action, which determines that the impact of crude oil volatility on interest rate is bound to lag. It can be seen from the Figure that before the opening of the market, the impact of fluctuations in world crude oil prices on interest rates turns positive from negative in the third period, roughly symmetrical with pulse response Figure of inflation, which is also consistent with the economic significance: When high inflation appears, interest rates are usually low, and government will adopt a tight monetary policy to increase interest rates so that the inflation can be curbed. When interest rates reach a high level, which usually accompanied by deflation, and government will take a loose monetary policy and lower interest rates to stimulate development of economy. Figure 3-7 shows that in recent years, with the exacerbation of domestic inflation, the stringency of tight monetary policies increased significantly. Pulse fluctuations still focus on the positive of Y-axis, which has inextricably linked with government's policy. Government has raised deposit reserve ratio of large financial institutions 29 times during the five years from January 2007 to February 2012, and the deposit reserve ratio has raised from 9.5% to 20.5 %. With the rise of interest rates, inflation has been well suppressed. Therefore, it is appropriate to adopt tight monetary policies when international crude oil prices increase.

CONCLUSIONS AND SUGGESTIONS

From SVAR model, we can see that international crude oil price has significant effects on China's macroeconomic after the opening of the oil market. The impact not only accelerates the decline of industrial output, but also brings about more serious inflation. With gradual integration of domestic oil prices into the world and constant increasing dependence on foreign oil, the impact of international crude oil price volatility on China's economy will continuously strengthen. The price of international crude oil has changed frequently over the years. To reduce the impact of crude oil prices on our economy, we must constantly improve domestic oil pricing mechanism and establish futures market of domestic crude oil as soon as possible. At the same time, we should also continuously optimize the structure of domestic energy consumption.

First, we should improve pricing mechanism of our refined oil market and do our best to make the price of refined petroleum market-oriented, so that the signal of oil price can enhance the ability to conduct relevant industry and consumer. In addition, under the reasonable guidance to production and consumption, economic life will finally reduce the over-reliance on oil.

Second, we should establish domestic futures market of crude oil and strive for crude oil pricing in order to form a sound system of national oil market; thus, we can avoid the risk caused by fluctuations in the international crude oil prices. At the same time, it is more helpful to strengthen our discourse power in international crude oil trading.

Third, we should improve energy utilization efficiency and optimize consumption structure of energy. Government needs to accelerate the exploration and utilization of substitutes for petroleum resources, and improve the proportion of natural gas and other high-efficient energies in China’s energy consumption structure, which is the fundamental way to strengthen ability to cope with fluctuations in international oil prices as well as to reduce the impact on domestic economy.

At the same time, in order to avoid decline of economic output caused by tight monetary policy in the long term, government should think more about neutral monetary policy to alleviate the negative influences resulted from excessive tight policies.

Due to the limited space, this paper just explores the impact of international crude oil price volatility on macro-variables. The research on the interaction between macro-economic variables, which explores the long-term impact of monetary policy changes in M2 and interest rates on output and inflation, deserves further study.

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