

Oil Prices, Economic Growth, Price Level and Stock Price Index in a Structural Cointegrated VAR Model in China

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Abstract—In this paper, we analyzed the relationship between the international crude oil prices and Chinese macro-economic variables using Granger Causality Test. We found that the cointegration relationship between the crude oil price and Chinese economic growth, and the quantitative analysis using VAR model and impulse response analysis. Finally, we recommended some suggestions and measures to cope with the international oil price shocks to our country.

Keywords-Unit Root Test, Johansen Cointegration test, VAR model, Impulse response analysis

1. Introduction

Dramatic increases in the price of oil are generally acknowledged to have important effects on both economic activity. Thus, not surprisingly, a considerable body of economic research has studied oil price shocks influence economic variables. Several economists have offered a number of theoretical explanations to account for the inverse relationship between oil price changes and the level of economic activity. The most intuitive justification is that oil price shocks are indicative of the increased scarcity of energy^[1]. Because high energy costs lower firms' profits, they normally reduce the willingness to purchase new capital goods; however, if the increase in energy prices looks to be permanent, firms might decide that it makes sense for them to invest in more energy-efficient capital, moderating the decline in their capital spending.

Chinese economy grows rapidly with oil demand dramatically expanding. Oil price may impact the whole economy from raw material to final products. There are three ways for international oil price impact on Chinese economy. First, it influences economic growth. Second, the inflation will appear if international oil price continues climbing. As an energy product, the oil price will inevitably drive up the prices of the relevant industries. Third, Chinese capital market such as the stock market may be affected by oil price fluctuation.

There are a great deal of research on the topic of oil prices fluctuation's impact on macro-economy, there are several theoretical perspectives as follows: firstly, the supply shocks theory. In the paper of Woodford (1996), Finn (2000) and Brown and Yucel (2002), they held the opinion that the oil price shocks (it primarily refers to the case of oil price increases) would result in the reduction of energy inputs, thus it led to outputs decline as well as labor's marginal product decrease which may potentially bring about reduction in investment, rising interest rates and inflation. Secondly, the income transfer theory. Fried and Schulze (1975) proposed that the rising of oil prices transferred the income of oil-importing countries to oil-exporting countries, so the oil-importing countries would decline their consumption^[2]. While as the decreasing demand of importing countries is greater than the increase of exporting countries, thus the whole world consumption would decline, which would finally inhibit economic growth, a recession happens to be the worst. Thirdly, the total channel and channel configuration theory. Lee and Ni (2002) study the U.S. macro-economy and find

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that in the aspect of total channel, the oil price shock mainly makes high-energy consuming industries (eg: chemical industry) reduce their input as their input costs have grown up; in the aspect of channel configuration, the shock primarily decreases the demand of the product of low-energy consuming industries^[3]; both of these effects will lead to economic recession. Fourthly, the theory is concerned in the angle of labor market. Carruth, Hooker and Oswald (1998) based on the model of efficiency wages and found that the changes in oil prices would affect the equilibrium unemployment rate. Fifthly, the interest rates channel. Balke, Brown and Yucel (2002) believed that the transmission of asymmetric effects brought by oil price shock mainly through its non-symmetric impact on interest rates, while the interest rates have a significant effect on output^[4].

The paper is organized as follows. Section II covers the empirical analysis on Chinese economy and international crude oil price using Granger Causality Test. And the result of using VAR model and impulse response analysis is that the cointegration relationship exists between the crude oil price and Chinese economic growth. Section III presents the summary and conclusions.

2. Methodology

The proposed methodology considers oil prices as potentially endogenous in an economic framework. This will enable researchers as well as policy makers to identify explicitly the exact effects of oil prices changes on certain substantial macroeconomic variables and/or asset prices, such as stock prices. The methodology uses the vector error-correction (VEC) or vector autoregressive (VAR) model as appropriate^[5], where we decompose the unpredictable changes in oil prices into mutually orthogonal components. In this paper, the VAR model contains four variables, domestic production gross growth rate(gdp), producer price index(ppi) and A-share index of Shanghai Security Exchange (index) which is a weighted result calculated by the flow of the market value, real oil prices. The VAR form is given as follows:

$$Y_t = C + A_1 Y_{t-1} + A_2 Y_{t-2} + \dots + A_p Y_{t-p} + \varepsilon_t \quad (1)$$

A structural cointegrated VAR model has been considered for studying the direct effects of crude oil price changes on output, integral price level, the capital returns in stock market, and then pulse-response analysis has been applied to discuss the relationship among the variables further. The VMA form is given as follows:

$$Y_{it} = c_{ij}^{(0)} \varepsilon_{jt} + c_{ij}^{(1)} \varepsilon_{j,t-1} + c_{ij}^{(2)} \varepsilon_{j,t-2} + \dots + c_{ij}^{(p)} \varepsilon_{j,t-p} + \dots \quad (2)$$

3. Empirical analysis

3.1. Data description

The sample period is selected from the first quarter in 1996 to the first quarter in 2009. In this section we adopt the natural logarithm forms of the data, namely lngdp, lnindex, lnppi and lnprice.

Oil prices used are the Cushing, OK WTI FOB port of shipment of the spot oil prices from the Energy Information Administration Web site. Quarterly GDP growth rate are taken from the WIND IT. We adopt monthly data of A-share index of Shanghai Security Exchange(SSE) from the Center of China Economic Research Services (CCER), and then get the final necessary quarterly data after an average.

3.2. Unit root tests and cointegration tests

We test for unit roots in the natural logarithms of our variables. We test the null hypothesis of non-stationary variables versus the alternative hypothesis of stationary variables using the Augmented Dickey-Fuller (ADF) statistic (Dickey and Fuller, 1981). We employ the Akaike information criteria (AIC) to select the lag length from the ADF test. Table I reports the results, we cannot reject the null hypothesis that all variables contain a unit root at the 5-percent significant level. Then, the ADF test is used to the first-order differential of the above variables, suggesting that gdp, ppi and index in our study are I (1).

TABLE I. TESTS FOR UNIT ROOTS

Variables	ADF statistic	p value	1% level	5% level
lnprice	-1.775	0.9996	-3.597	-2.933
D(lnprice)	-4.034	0.0027	-3.568	-2.921
lngdp	-1.204	0.2341	-3.563	-2.919
D(lngdp)	-4.903	0.0012	-4.1485	-3.500
lnindex	-1.607	0.4702	-3.597	-2.933

Dlnindex	-3.705	0.0076	-3.601	-2.935
lnppi	-2.832	0.0609	-3.565	-2.920
D (lnppi)	-4.339	0.0059	-4.148	-3.5004

We employ cointegration tests, based on the methodology of Johansen and Juselius (1990), for the variables in this study — oil prices, domestic production gross growth rate, producer price index and A-share index of Shanghai Security Exchange. Table II reports the tests for cointegration.

According to the individual estimates of the eigenvalues, the max-eigenvalue cointegrating test strongly suggests the existence of one long-run relationship for the four variables, where the appropriate number of cointegrating vectors is 2. As a pre-test, we estimate VAR models with varying lag lengths and perform AIC and SC to select the appropriate lag length. In all cases, we choose two lags.

3.3. VAR Model

In this section we set up a structural cointegrated VAR model in order to describe the macroeconomic system consisting of the above four variables, which can also measure the impact of a small change on the remaining other variables, including the extent of the influence, direction and duration. The results of VAR model are shown in Tab.III.

TABLE II JOHANSEN COINTEGRATION TEST RESULTS

cointegration vector	Test			
	Trace statistic	P value	The max-eigenvalue	P value
None	71.3	0.0001	32.58	0.0104
At least 1	38.72	0.0036	24.07	0.0187
At least 2	14.65	0.0668	13.63	0.0628

NOTES: THE SELECTION OF COINTEGRATING RELATIONS IS BASED ON .05 LEVEL CRITICAL VALUES FROM OSTERWALD-LENUM (1992)

TABLE.III VAR MODEL RESULTS

	lngdp	lnindex	lnppi	lnprice
lngdp(-1)	0.6	1.49	0.03	0.15
lngdp(-2)	0.19	-0.76	0.02	0.24
lnindex(-1)	0.02	1.41	-0.01	0.04
lnindex(-2)	-0.07	-0.49	0.01	-0.05
lnppi(-1)	0.31	-1.56	0.94	-0.41
lnppi(-2)	-1.41	-0.99	-0.26	-0.47
lnprice(-1)	0.17	-0.6	0.05	1.29
lnprice(-2)	-0.01	0.87	-0.04	0.35
C	5.26	9.68	1.37	3.49
R-squared	0.83	0.97	0.85	0.95

3.4. Impulse response analysis

The impulse response traces the effect on current and future values of the endogenous variables of one standard deviation shock to the variables. In Fig. 1, Fig. 2 and Fig. 3, the estimated impulse responses with the corresponding standard confidence error bands are presented. The responses of the dependent variables are obtained by considering one standard deviation shocks, i.e. shocks whose amplitude is equal to the standard errors of the underlying estimated equations. The impulse responses to an oil price shock indicate that an oil price increase is generally followed by a rise in GDP

Fig. 1 illustrates that coefficient measuring the impact of oil prices on the domestic production gross growth rate is positive i.e. it can say that increasing oil price doesn't change the trend of rapid economic growth. There may be the following reasons: firstly, coal plays the dominate role in production and consumption in China. In detail, coal consumption accounts for 66.7 percent, while oil consumption only accounts for 23 percent, that is to say international oil price rise cannot lead to slow down domestic economic

growth. Secondly, domestic oil prices still not fully line with international oil prices, thus impact on GDP growth caused by the international oil prices volatility is not much significant.

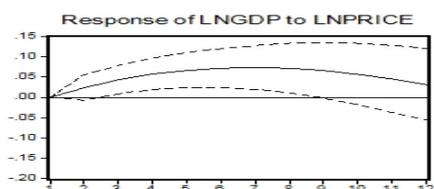


Fig.1. Impulse response of $\ln(\text{gdp})$ and $\ln(\text{price})$

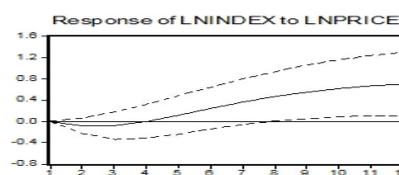


Fig.2. Impulse response of $\ln(\text{index})$ and $\ln(\text{price})$

In Fig. 2 we can see that the trend of the share index is falling firstly and rising in the end. Because oil prices are raised up, companies' production costs have to be increased and their cash flow be deteriorated, their stock prices drop consequently. But in the latter, the oil price is under control in China, so-called *upside down oil prices*.

Compared with similar enterprises in other countries, the companies in China view the high oil prices as the advantages of themselves, and it makes the investors hold the same idea and they have the positive anticipation. Therefore the stock prices rise up and the index goes up finally. In addition, speculation exist in the market may be the other reason that leads to the positive correlation of the two variables in emerging markets^[6]. In contrast to mature markets, investors hold the stocks as a kind of financial management, international oil price fluctuation and index is negative correlation.

In Fig.3, the phenomenon is described that innovations in the international oil price have modest effects on ppi. The overall price level, including labors' wages, interest rates and rents increasing accompany with oil prices going up. However the impact cannot be continuing to expand for many periods because of the energy consumption structure in China.

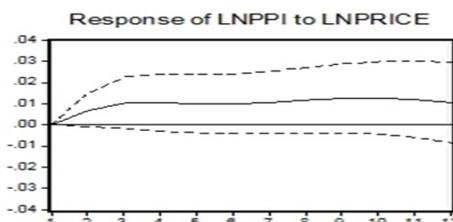


Fig.3. Impulse response of $\ln(\text{ppi})$ and $\ln(\text{price})$

4. Conclusion

In this paper we have specified and estimated a structural vector autoregressive model for the four variables aimed at verifying if the oil price changes of the last fourteen years have affected macroeconomic variables and have been transmitted to the economic system. We have investigated long-run as well as short-run relationships among the macroeconomic variables oil prices, GDP, PPI, and A-share stock index in Shanghai. Our results can be summarized as follows: i) Johansen cointegration suggested that the impact of oil shocks on these variables is not limited to the short run. ii) according to the estimated coefficients of the structural part of the model, the null hypothesis of an influence of oil prices on the four variables cannot be rejected. iii) impulse response analysis suggests, the existence of an instantaneous, temporary effect of oil price innovations on GDP growth.

Our future research efforts will follow two main directions. First, we are confident that the recent econometric techniques based on multivariate regime switching models are able to offer a more realistic representation of the dynamics of business cycle movements. Second, our analysis will be addressed to verify possible asymmetric relationships between oil prices and the macroeconomics.

5. References

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