Refereed paper presented at the ACESA2006 Emerging China: Internal Challenges and Global Implications, Victoria University, Melbourne, 13-14 July 2006

Impacts of External Oil Supply Shocks on the Chinese Economy

Yun-kwong Kwok[a], Yanchun Zhang[b]

[a]School of Accounting, Economics, and Finance, Deakin University, Australia
[b]Department of Economics, San Francisco State University, USA
yun-kwong.kwok@deakin.edu.au, yanchun@sfsu.edu

Presenter's biography: Dr. Yun-kwong Kwok

Lecturer of Economics,
School of Accounting, Economics, and Finance
Deakin University, Melbourne

PhD, MA, University of Virginia
MPhil, BSSc, Chinese University of Hong Kong

Research interest: international economics, macroeconomics

Publications:

Kwok, Yun-kwong, "Global Factor Trade with Differentiated Factor Prices and Factor Intensities," *Canadian Journal of Economics*, forthcoming (August, 2006).

Kwok, Yun-kwong, "To Save or To Consume: Linking Growth Theory with Keynesian Model," *Journal of Economic Education*, forthcoming (Spring, 2007).

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Yun-kwong Kwok[a], Yanchun Zhang[b]

[a]School of Accounting, Economics, and Finance, Deakin University, Australia
[b]Department of Economics, San Francisco State University, USA
yun-kwong.kwok@deakin.edu.au, yanchun@sfsu.edu

May 10, 2006

Abstract: Using the data since China's economic reform, this paper investigates the impacts of external oil supply shocks on the Chinese economy.

Keywords: Chinese Economy, Oil Shocks, Real GDP

1. Introduction

China's dependence on imported oil has increased at a fast pace along with its unprecedented high rates of economic growth in the past two decades. The question we are interested in exploring in this paper is how the oil supply bottlenecks could have affected and would affect China's economic growth. Due to the increasing international linkages under the new wave of globalization, this question becomes important not only to China, but also to the whole world because the global economy is becoming more and more closely tied to the economic performance of China.

Motivated by the concern of the Chinese economy's vulnerability to external oil market fluctuations, this paper investigates the impacts of exogenous oil supply shocks on China's real GDP growth and inflation rate. This study helps us understand the linkage between resources inputs and Chinese economy and will contribute to optimizing China's long term development strategy.

2. Oil and the Chinese Economy

For more than twenty-five years after the commencing of economic reform in 1978, China has been continually growing at a rapid rate. Based on World Bank's World Development Indicators, between 1978 and 2004, China's annual real GDP growth rate was 9.5 percent on average.

Accompanying this rapid growth, China's demand for oil is also increasing rapidly. As shown in Figure 1, China's consumption of petroleum has increased from around 1.7 million barrels per day in early 1980s to over 5.5 million barrels per day in 2003. In 2004, China's oil consumption rose to 6.5 million barrels per day and had surpassed Japan as the world's second-largest oil consumer.[1]

Though not as well noticed as its skyrocketing demand for oil, China is in fact also one of the largest oil producers in the world. The production of petroleum in China,

[1] Source: Energy Information Administration (2005b), Non-OPEC Fact Sheet.

which is also plotted in Figure 1, has increased from around 2 million barrels per day in early 1980s to around 3.5 million barrels per day in early 2000s. According to Energy Information Administration (2005a) and BP (2005), China was ranked the sixth in oil production in 2003 and the twelfth in proved oil reserves in 2004.

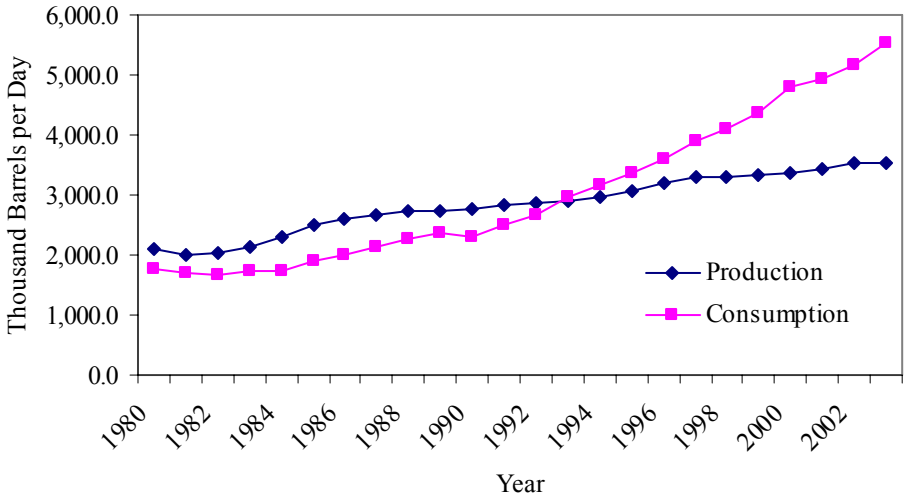

Figure 1: Oil production and consumption of China, 1980-2003.[2]

Nevertheless, despite its steady growth over the past two decades, China's oil production can no longer fulfil its own demand since early 1990s. As shown in Figure 1, China's oil consumption has passed its oil production in around 1992-93. Figure 2 shows the net imports of crude oil and petroleum products of China since the economic reform. Again, in around 1992-93, China has transformed from a net oil exporter to a net oil importer.

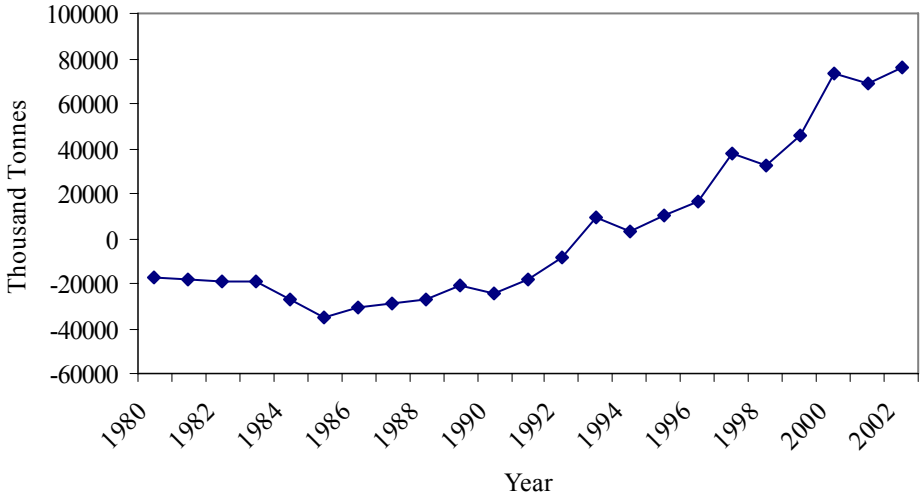

Figure 2: Net imports of crude oil and petroleum products of China, 1980-2002.[3]

[2] Source: Energy Information Administration (2005a), *International Energy Annual 2003*.
[3] Source: International Energy Agency (2004), *IEA Oil Information 2004*.

As the Chinese economy is becoming more relied on oil imports, it is also expected to be more vulnerable to external oil shocks. Figure 3 shows the Brent crude oil price from 1982 to 2005. For over two decades since its economic reform, China is facing a relatively stable external oil price. Nonetheless, since 2002, the oil price has risen from around USD20 per barrel to more than USD60 per barrel in 2006. As a result, the issue of energy security concerns China. Actions have been taken by the Chinese government to mitigate the economic and political risks of external oil supply disturbances. These actions include initiating its strategic oil reserves program, diversifying import sources (Bahgat 2005), investing in foreign oil production facilities (Yates 2005), and attracting foreign investment in Chinese energy activities (see further discussions in International Energy Agency 2000, Downs 2004, and Zweig and Bi 2005).

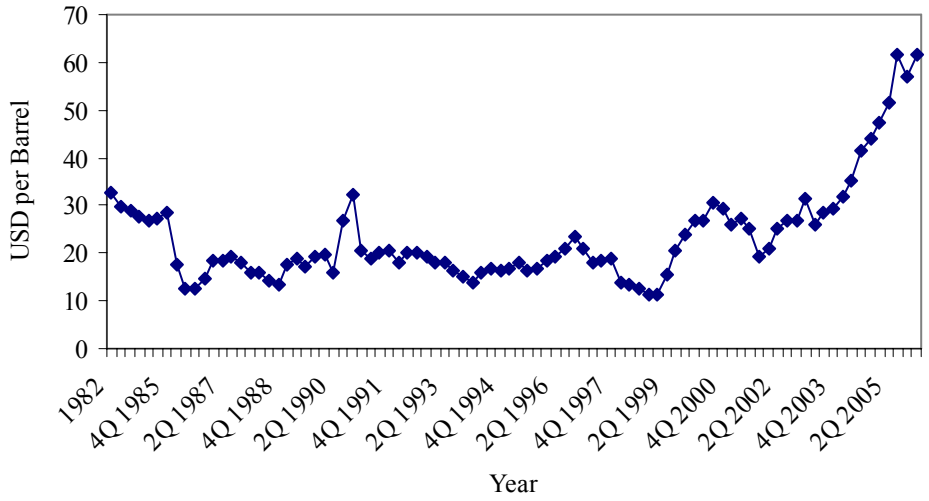

Figure 3: Brent crude oil spot price (quarterly average), 1982-2005.[4]

Due to the increasing international linkages in the new wave of globalization, the global economy is closely tied to the economic performance of the Chinese economy. Motivated by the concern of the Chinese economy's vulnerability to external oil market fluctuations, the following sections investigate the impacts of past oil shocks on the Chinese economy.

3. Methodology and Data

This paper is going to study the relationship between exogenous oil shocks and two China's macroeconomic aggregates: real GDP growth rate and the CPI-inflation rate.

Although it is the recent increase in oil price that worries the general public, its impacts cannot be analysed by running a regression of the real GDP of China directly on the oil price. This is because the world oil price may be endogenous with respect to the real GDP of China. In fact, there are suggestions claiming that it is China's rampant demand for oil that causes the world oil price hikes. Though this claim has yet been proved, this paper avoids making any assumption about the exogeneity of oil price. Instead, this paper adopted the data of exogenous oil supply shocks compiled by Kilian (2005a) as the explanatory variable.

[4] Source: International Energy Agency (2006), *IEA Energy Prices and Taxes 2006*.

Kilian quantified the oil supply disturbances through the following procedures. Firstly, he examined the historical political incidences, such as wars and civil unrests, faced by major OPEC countries. Secondly, he estimated what the oil production levels of these OPEC countries would be if there were not these political incidences. To do so, he extrapolated the pre-political-incidence oil production levels of these countries based on the production growths of other similar oil-exporting countries that are not affected by the political incidences. Finally, he aggregated the differences between the post-political-incidence oil production levels and the counterfactual production levels across OPEC countries to form the estimated OPEC oil supply disturbances.[5] The share of this estimated OPEC oil supply disturbances in the world total oil output gives a normalized measure of the oil supply disturbances. The exogenous OPEC oil supply shock is given by the change in the normalized oil supply disturbances.

Figure 4 plots Kilian's exogenous OPEC oil shocks since 1978. We can see that the major oil shocks since the economic reform in China are during the Iranian Revolution in 1978/79, the beginning of Iran-Iraq War in early 1980s, the Gulf War in 1990/91, the Venezuela Civil Unrest in 2002, and the Iraq War in 2003.

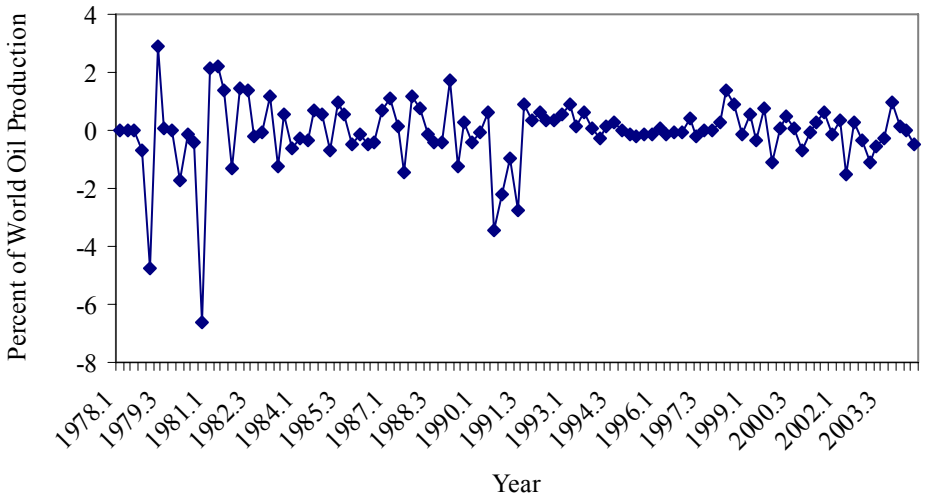

Figure 4: Exogenous OPEC oil supply shocks, 1978-2004.[6]

Since China's quarterly real GDP data is only available after 1995 Q1, their estimates are adopted from Abeysinghe and Rajaguru (2004). Abeysinghe and Rajaguru recovered the quarterly real GDP for China from a forecast evaluation. They applied the technique that stemmed from Chow and Lin (1971), Fernandez (1981), and Litterman (1983) to China's annual real GDP data, which are available since 1978 (China Statistical Yearbook). Their methodology involves running a regression of annual real GDP on annual related macroeconomic series (nominal M1 and nominal total external trade) and thereafter using quarterly related series to predict quarterly real GDP. Since China only publishes quarterly nominal GDP on a cumulative basis and the converted real GDP growth rates, Abeysinghe and Rajaguru have to first convert both nominal GDP levels

[5] Advantages of this approach of quantifying oil supply disturbances are detailed in Killian (2005a).
[6] Source: Kilian (2005a), http://www-personal.umich.edu/~lkilian/.

and real GDP growth rates into quarterly figures and then used 1997 as the base year to recover their quarterly real GDP series.

The quarterly real GDP figures published in Abeysinghe and Rajaguru (2004) are not seasonally adjusted. We apply the Census X12 method (multiplicative), which is the standard method used by the U.S. Bureau of Census to seasonally adjust publicly released data, to construct the seasonally adjusted real GDP figures for China.

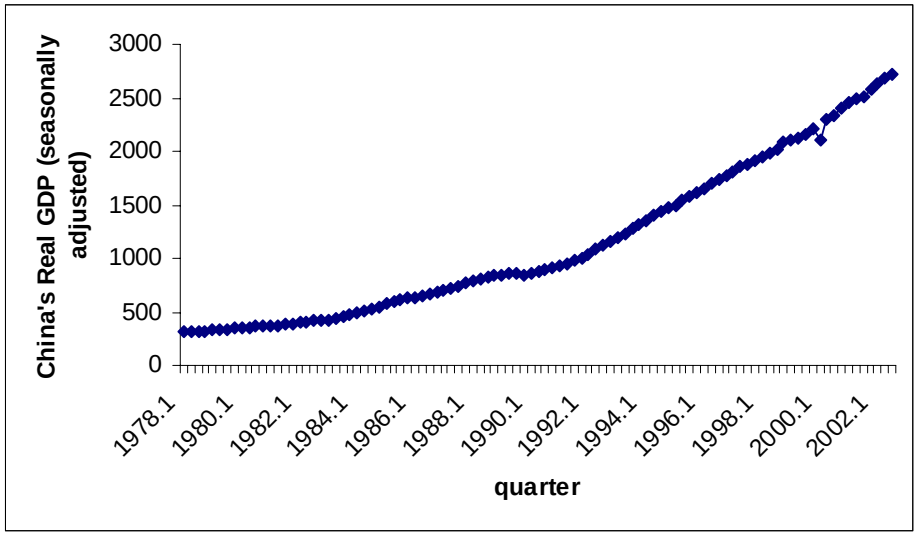

Figure 5: China's Real GDP Data, 1978Q1-2002Q3.

The quarterly CPI-inflation data is extracted from the IMF's IFS database. The data is only available from 1987Q1.

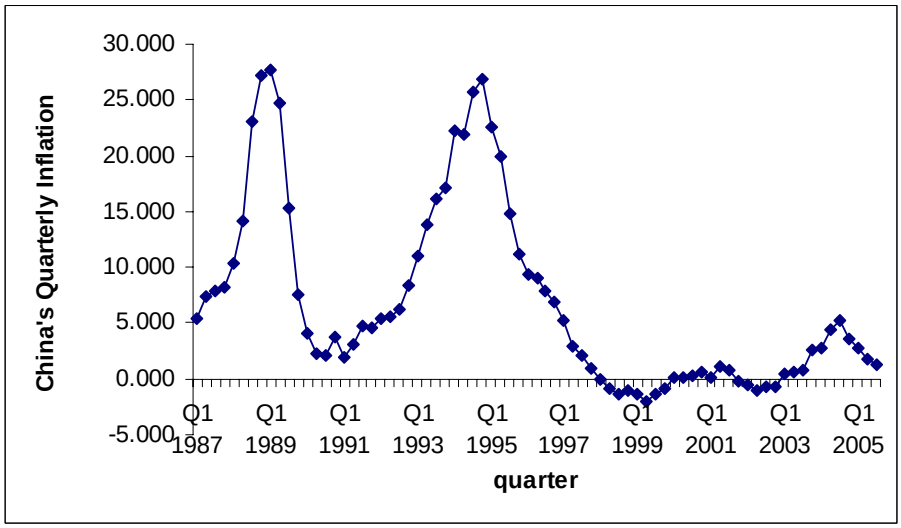

Figure 6: China's CPI-Based Inflation Data, 1987Q1-2005Q3.

4. Empirical Results

In the paper, we use a linear regression model to study the relationship between exogenous oil supply shocks identified by Kilian (2005a) and China's real GDP growth rate and CPI-inflation rate. We regress the two macroeconomic aggregates individually on an intercept, four lags of the dependent variable, and eight lags of the exogenous oil

supply shock. The number of lags is consistent with the assumptions used by Hamilton (2003) and Kilian (2005a). Our interest is to calculate the implied impulse responses, which will measure the causal effects of the exogenous variations in oil supply.

The regression analysis will be based on seasonally adjusted real GDP data (1978Q1-2002Q3) and CPI-based inflation data (1987Q1-2004Q3). We follow Kilian (2005a) to treat the oil production shocks as strongly exogenous. The effects of oil shocks on China's real GDP and inflation rate are estimated using the following two linear regressions:

$$\Delta RGDP_t = \alpha_t + \sum_{i=1}^{4} \beta_t \Delta RGDP_{t-i} + \sum_{j=1}^{8} \gamma_j oil_{t-j} + u_t,$$

$$\Delta \inf_t = \alpha_t + \sum_{i=1}^{4} \lambda_t \inf_{t-i} + \sum_{j=1}^{8} \eta_j oil_{t-j} + v_t,$$

The error terms are serially uncorrelated. "Provided that the exogenous oil supply shock regressors are not correlated with any omitted variables, the implied responses will measure the casual effects of the exogenous variations in oil supply." (Kilian 2005a)

The OLS estimates of the above two regressions are listed in Table 1 and Table 2:

Table1: The Linear OLS Regression of RGDP Growth Rates on Lagged RGDP Growth Rates and Lagged Oil Production Shocks

Parameters	Estimates	Robust Standard Errors
β_1	0.139168	0.13152
β_2	0.256304	0.105414
β_3	0.312631	0.124037
β_4	-0.07106	0.152256
γ_1	0.084144	0.085098
γ_2	0.123515	0.07709
γ_3	-0.03543	0.106186
γ_4	-0.1022	0.063824
γ_5	-0.13369	0.079665
γ_6	-0.07592	0.08073
γ_7	0.007976	0.071146
γ_8	0.170983	0.084053
α	0.853872	0.423663

Table2: The Linear OLS Regression of Inflation Rates on Lagged Inflation Rates and Lagged Oil Production Shocks

Parameters	Estimates	Robust Standard Errors
β_1	1.510853	0.143529
β_2	-0.46552	0.331433
β_3	-0.27173	0.341836
β_4	0.145652	0.154299
γ_1	0.177407	0.358583

γ_2	0.039816	0.35339
γ_3	-0.46002	0.181784
γ_4	0.446563	0.328251
γ_5	0.329356	0.165966
γ_6	-0.30521	0.294021
γ_7	-0.03583	0.219336
γ_8	-0.14262	0.326431
α	0.355121	0.206288

Based on estimates, we simulate the path of real GDP growth rate and CPI-based inflation rate to assess the impact of an exogenous 10% reduction in global oil production as in Kilian (2005a).

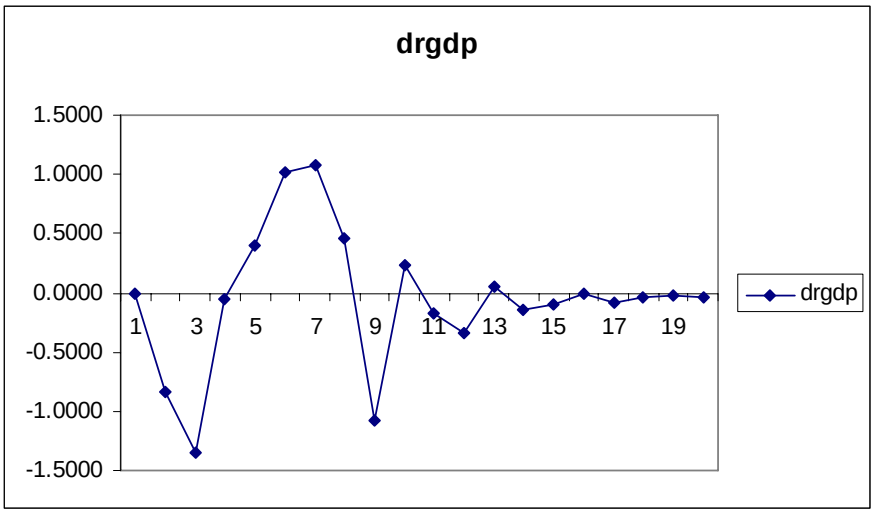

Figure 7: Dynamic Effect of a 10% World Oil Supply Disruption on China's RGDP Growth Rate

Figure 7 shows the response of real GDP growth rates responding to an exogenous 10% drop in world oil production. From the figure, we can see that a negative oil supply shock causes a sharp decrease of the real GDP growth rates in the first four quarters (i.e., the first year). This is not surprising because as China is taking up the role as the "world factory," it is more and more relying on petroleum imports.

Nonetheless, Figure 7 also shows that China can soon recover and resume a positive growth in the second year. An explanation of that is that China is also well endowed with oil and other oil-substitutes. For example, China is one of the countries that endowed with the largest coal reserves. A negative oil shock can soon causes an increase production of coal and other oil-substitutes. It may also stimulate industries to adjust their production process and explore the ways of using other natural resources.

The negative oil shock may still have some negative impacts on China's real GDP growth in the long run, but it soon dampens after two years.

Figure 8 exhibits the response of China's inflation rate after an exogenous 10% disruption in world oil production. From the figure, we can see that a negative oil supply shock causes a significant deflation. This shows that a negative oil shock may have a

much larger negative impact on the aggregate demand rather than on the aggregate supply. Figure 7 shows that a negative oil shock may not have a huge negative impact on the real GDP which implies that the negative impact of world oil disruption on the aggregate supply may not be huge. But if the negative oil shock can cause a huge negative impact on the aggregate demand, such as the consumer's confidence, than it will result in a deflation over time. When the aggregate demand drops faster than the aggregate supply, the general price level will drop.

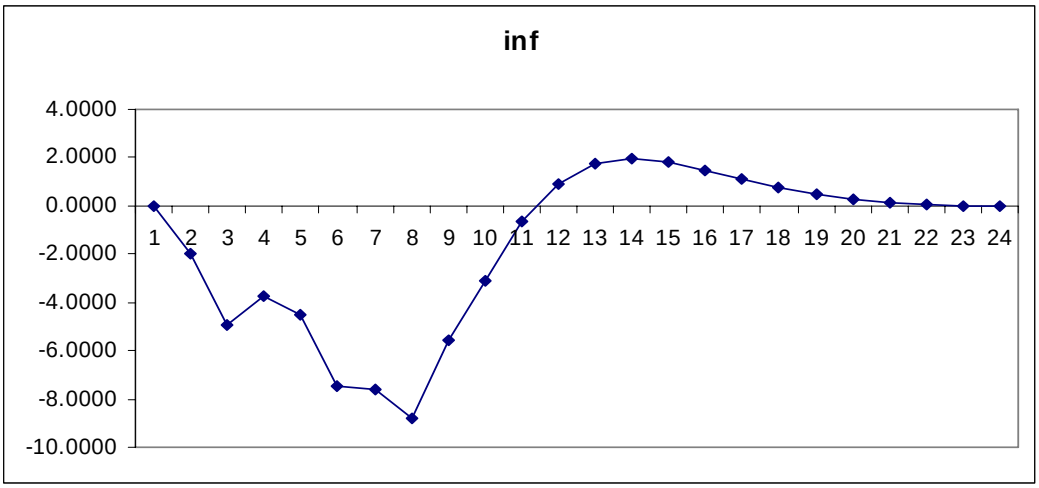

Figure 8: Dynamic Effect of a 10% World Oil Supply Disruption on China's CPI-Based Inflation Rate

5. Conclusions

This paper investigates the impacts of exogenous oil supply shocks on China's real GDP growth and inflation rate. The results show that a negative oil supply shock does not seem to have an as significant negative impact on China's real GDP growth as that on other industrialized countries. A reason of this can be that China is also well endowed with natural resources, especially coal, a major substitute of oil. Anther reason is that our data sample is not long enough and, over the major time horizon of our sample, China had not transformed into a complete market economy yet. Further studies in the future is strongly suggested, when more data is available and when Chinese economy converges closer to a standard market economy.

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