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The impacts of global oil price shocks on China's fundamental industries

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HIGHLIGHTS

- We investigate the impacts of oil price shocks on China's fundamental industries.
- Jump behavior does exist in the crude oil market.
- The impacts of oil price shocks are asymmetric.
- China's four commodity markets are affected by the jump behavior.

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ABSTRACT

This paper investigated the impacts of oil price shocks on China's fundamental industries. In order to analyze the reactions of different industries to oil price shocks, we focused on four fundamental industries: grains, metals, petrochemicals and oil fats. We separated the oil price shocks into two parts, positive and negative parts, to investigate how commodity markets react when oil prices go up and down. We further studied the extreme price movements, called jumps, existing in the oil markets and how jump behavior has affected China's commodity markets. Our results suggest that asymmetric effects of oil price shocks did exist in the four markets and the negative oil price shocks had stronger influences on the four markets in China. The petrochemicals market suffered most from the oil price shocks, and the grains market was least sensitive to the shocks. When jumps occurred in the crude oil market, the four commodity markets would be affected differently. The oil fats market and petrochemicals market tended to "overreact" to jumps.

1. Introduction

Crude oil, the most influential resource of raw materials and primary energies, has strategic impacts on economic development and social stability. With recent rapid economic growth, China's crude oil consumption has increased significantly. In 2003, China surpassed Japan as the world's second largest consumer of crude oil after the US. At the end of 2012, China's consumption of crude oil reached 476.13 million tons. However, due to the domestic production of crude oil failing to meet the huge demand, China is facing severe challenges from a long-term energy supply gap and is increasingly dependent on crude oil in the process of economic transitions. In 2012, China's domestic production of crude oil was only 207.48 million tons, but the supply gap was 268.65 million tons. China's dependence on imported crude oil increased to 56.42%. In September 2013, the Energy Information Administration (EIA) announced that China had already become the world's largest net importer of crude oil.

Moreover, due to fluctuations in the world's economy and various political events, the global crude oil price changes fiercely. In September 2008, West Texas Intermediate (WTI) crude oil price experienced a 16.41% increase in a single day. Since 2002, global crude oil price continued to increase and peaked at $147 per barrel in 2008. Later, the oil price suffered a sharp decline, but now it still remains above $100 per barrel. Crude oil, the lifeblood of the industrial economy, strongly relates to economic security. Because of oil price fluctuations and heavy dependence on imported oil, crude oil volatility will inevitably affect China's economy. Therefore, it is necessary to investigate the effects of oil price volatility and to hedge the risk of oil price fluctuations.

In addition, volatility in crude oil prices could be transmitted to the bulk commodity markets through various transmission mechanisms and affect relevant industries. The most affected sectors are the oil-related industries (oil exploration, production, refining, etc.), highly oil-sensitive transportation industries (airlines, trucking, railroads, etc.) and highly oil-intensive

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manufacturing industries (aluminum, steel, etc.) (Hammoudeh et al., 2004). Further, the reactions of different commodity markets to oil price shocks vary, resulting from different market efficiencies and correlations with crude oil. This research will help us achieve insight into the specific impacts of oil price shocks on the economy at an industry level, and this is now a new research trend (Baffes, 2007; Jiménez-Rodríguez, 2008). With increasing dependence on global crude oil, it is urgent to investigate the impacts of oil price fluctuations on China's economy at an industry level. Therefore, our research mainly focuses on the impacts of oil price shocks on China's fundamental industries.

In order to investigate the impacts of oil price shocks on China's economy at an industry level, we selected four fundamental industries: grains, metals, petrochemicals and oil fats, according to data availability. In addition, to better describe the crude oil market, extreme price movements, called jumps, are also taken into consideration. We applied the Autoregressive Conditional Jump Intensity model (ARJI) developed by Chan and Maheu (2002), incorporating with the GARCH process (Bollerslev, 1986), to describe the volatility process and jump behavior of WTI oil. We separated the oil price shocks into two parts, positive and negative parts, to investigate how commodity markets react when oil prices go up and down. Moreover, price jumps will lead to an increasing volatility in the oil market, so related industries would be affected. Jump behavior in crude oil prices was also taken into consideration in order to analyze its impacts on commodity markets. Through the ARJI–GARCH model, jump intensity series are extracted to further examine the impacts of jump behavior on China's commodity markets. Our results suggest that asymmetric effects of oil price shocks did exist in the four markets and the negative oil price shocks had stronger influences on the four indices in China. Within the four markets, comparatively, the petrochemicals index suffered most from oil price shocks, contrary to the grains market, which proved less sensitive to oil price shocks. Ultimately, jump behavior of crude oil has different impacts on the four markets.

2. Literature review

The existing research is extensively concerned with the relationship between crude oil prices and macro-economy (Brown and Yücel, 2002; Darby, 1982; Hamilton, 1983; Mork, 1989), and the results suggested oil price increases had negative impacts on GDP growth and also contributed to higher inflation pressure in oil-importing countries (Jiménez-Rodríguez, 2008). Negative correlation was found between oil price changes and GNP in the US (Hamilton, 1983). The oil price shocks were important factors resulting in some of the US recessions prior to 1972. Based on examining the relationship between crude oil prices and macro-economy when oil prices decreased, Mork (1989) extended Hamilton's (1983) work and concluded that oil price changes had asymmetric impacts on the national economy. Applying the structured co-integrated VAR model in G7 countries, Cologni and Manera (2008) reported that oil prices could affect inflation rate, and the inflation rate shocks would be further transmitted to the real economy by increasing interest rates.

In order to identify the impacts of oil price shocks on different economic sectors, many subsequent researchers began to analyze the reactions of different industries and markets to oil price shocks. After examining the co-movements of various commodities, including wheat, cotton, copper, crude oil, etc., Pindyck and Rotemberg (1990) demonstrated that the cross-price elasticity of demand and supply was zero, suggesting these commodities have no impacts on each other. Further, Lee and Ni (2002) verified that all sectors were not equally affected by oil price shocks. The most affected sectors were oil-related industries, highly oil-sensitive industries and highly oil-intensive manufacturing industries (Hammoudeh et al., 2004). Cong et al. (2008) argued that when oil volatility increased, the speculations in mining index and petrochemicals index might increase which would raise the returns of related companies. Baffes (2007), using data from 1960 to 2005, examined oil price pass-through to 35 different commodity markets. The results, at a more disaggregated level, illustrated that the fertilizer index had the highest pass-through (0.33), followed by agriculture (0.17) and metals (0.11). Precious metals also exhibited a strong response to oil price shocks.

The agriculture market has long been the subject of a vast literature that investigated the relationship between oil and agricultural commodity markets (Baffes, 2007; Yu et al., 2006; Zhang and Reed, 2008). Some studies indicated that a higher oil price would raise the input-cost, and this cost-push effect may result in a higher price of agricultural products (Campiche et al., 2007). Based on the co-integration test and the Granger Causality test, Nazlioglu and Soytas (2012) analyzed the dynamic correlations between crude oil price and 24 agricultural commodities prices, and the results provided strong evidence that oil price changes had significant impacts on agricultural commodity markets. It is also found that increase in oil price volatility will lead to higher food prices. This phenomenon indicated the risk transmission mechanism did exist between these two markets (Alghalith, 2010).

Moreover, conclusions concerning the impacts of oil price shocks on agricultural markets appeared to be different, owing to the differences of time periods, data sets and methodologies. For examples, Alom et al. (2011) reported a positive relationship between food prices and crude oil prices in the selected Asian and Pacific countries; however, the results varied across countries and period. It is also found that volatility spillover effects and risk pass-through effects of crude oil on the agricultural markets in the pre-crisis differed with those in the post-crisis period (Nazlioglu and Soytas, 2012). In contrast, Nazlioglu and Soytas (2011) analyzed the data from 1994 to 2010 in Turkey, implying that the impacts of oil price shocks on the Turkish agricultural commodity market were neutral. Other research, conducted by Gilbert (2010), Lombardi et al. (2012), Lee et al. (2010), and Zhang and Reed (2008), also supported the neutrality hypothesis.

In terms of non-energy commodities, metal markets also attracted the attentions of researchers. Baffes (2007) provided evidence that precious metal prices had strong reactions to oil price volatility. According to Beahm (2008), the relationship between gold prices and crude oil prices was a key driver of precious metal prices. Lescaroux (2009) found that the prices of crude oil and precious metals tended to move together. Hammoudeh and Yuan (2008) had drawn a similar conclusion after analyzing crude oil and precious metal markets in the US.

A growing body of research has emerged on investigating the relationship between crude oil and biofuels. Due to high oil prices and growing demand for environmental protection, biofuels, as a substitute for fossil energies, are developing rapidly. Using the global computable general equilibrium (CGE) model, Timilsina et al. (2011) analyzed the impacts of oil price shocks on biofuel expansion. The result showed that an increase in the oil price would raise global biofuel penetration. Haixia and Shiping (2013) applied the EGARCH model and the BEKK–MVGARCH model to analyze the price volatility spillover among crude oil, corn and fuel ethanol markets. They provided strong evidence that unidirectional spillover effects from the crude oil market to the corn and fuel ethanol markets did exist.

In terms of methodologies and econometric models, many studies applied GARCH family models to capture the volatility clustering (Aloui and Jammazi, 2009; Arouri et al., 2012), but these

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