Energy Policy 62 (2013) 878–886

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Volatility spillovers in China's crude oil, corn and fuel ethanol markets

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HIGHLIGHTS

- Employing univariate EGARCH model and BEKK-MVGARCH model, respectively. Unidirectional spillover effects from crude oil market to corn and fuel ethanol markets.
- Double-directional spillovers between corn market and fuel ethanol market.
- The spillover effects from corn and fuel ethanol markets to crude oil market are not significant.
- The empirical results indicate a higher interaction among crude oil, corn and fuel ethanol markets after September, 2008.

ARTICLE INFO

Article history:
Received 4 March 2013
Accepted 9 July 2013
Available online 14 August 2013

Keywords:
Fuel ethanol
Volatility spillovers
BEKK-GARCH model

ABSTRACT

Price volatility spillovers among China's crude oil, corn and fuel ethanol markets are analyzed based on weekly price data from September 5, 2003 to August 31, 2012, employing the univariate EGARCH model and the BEKK-MVGARCH model, respectively. The empirical results indicate a higher interaction among crude oil, corn and fuel ethanol markets after September, 2008. In the overall sample period, the results simultaneously provide strong evidence that there exist unidirectional spillover effects from the crude oil market to the corn and fuel ethanol markets, and double-directional spillovers between the corn market and the fuel ethanol market. However, the spillover effects from the corn and fuel ethanol markets to the crude oil market are not significant.

1. Introduction

Global agricultural commodity prices have changed considerably since the year 2007, attracting numerous economists' attention (Timmer, 2008; Serra, Zilberman, Gil and Goodwin, 2011). Timmer (2008), Barrera, Mallory and Garcia (2011) argued that fundamental factors, such as increasing demand from developing countries, devaluation of the US dollar, strong variability in crude oil prices and the expansion of biofuel production, all of which are interrelated, have combined to drive up agricultural commodity prices. However, the latter two factors have had a considerable impact on the prices of agricultural commodities.

In modern times, there is no doubt that agricultural prices have always been linked to crude oil prices through input and output costs. The view that the agricultural market is linked to energy markets through both input costs, such as costs of fertilizer and insecticides, and output costs, such as costs of the process of production, processing and transportation, has been confirmed by a number of studies (Tyner, 2010; Barrera, Mallory and Garcia, 2011). High crude oil prices bring about much more pressure on agricultural production through direct and indirect effects; however, another effect of high crude oil prices is the booming of biofuel, which strengthens the correlation between energy and agricultural prices.

Biofuels, most notably corn-based ethanol, have grown significantly in the past few years as a response to high volatilities in prices and the consumption structure of crude oil in China. For instance, the prices of crude oil have gone up continuously from 2003, peaking at $141.84/ barrel in July 2008, and increasing fivefold in 5 years. In terms of consumption structure, before 1996, the consumption of China's crude oil was nearly self-sufficient; however, from 1996, the production of crude oil in China has approximately maintained the 1996 level, but consumption dramatically increased, causing the amount of crude oil imported to rise significantly. By 2011, the amount of crude oil consumption reached 45,367.3 million; China's own production only accounted for 20,287.6 t, and 25,254.9 t were imported (illustrated in Fig. 1).

The production of biofuel, especially fuel ethanol, in China began at the end of the twentieth century, not only to achieve only energy safety but also to consume excess grain stocks, reducing the country's financial burden. Meanwhile, key grain-producing regions in China were suffering from difficulty in selling grains,

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http://dx.doi.org/10.1016/j.enpol.2013.07.026

and developing the fuel ethanol industry seemed to be a way to support the transformation of grains such as corn and wheat and increase the efficiency of grain utilization. Ethanol production could therefore help to form a stable and controllable grain consumption market and protect farmers' benefits. Thus, the government began to develop a corn-based fuel ethanol industry.

In 2002, fuel ethanol production in China only amounted to 30,000 t, among which over 80% was corn-based ethanol. However, after several years of development, China has become the third-largest ethanol producing and consuming country, following Brazil and the United States. In 2011, production of fuel ethanol sharply peaked at 1,930,000 t, among which over 60% was corn-based ethanol (China Chemical Industrial Equipment Association, CCIEA). It has been argued that soaring oil prices resulted in higher agricultural commodity prices through cost-push effects by increasing the cost of production (Campiche et al. 2007). At the same time, higher oil prices also influenced agricultural prices by increasing the demand for biofuel (Gilbert, 2010; Baffes and Haniotis, 2010). Fig. 2

Given these arguments, the traditional conclusion that the linkage between energy and agriculture prices is asymmetric, i.e., the energy market influences the agricultural market but not vice-versa, can be challenged because of the influence that agriculture could have on the energy economy through the fuel ethanol market. In particular, there might be feedback mechanisms that result in agricultural products leading crude oil prices, and one such mechanism may exist due to the use of some agricultural products in biofuel generation. The spillover effects model follows in Fig. 3.

In this context, ambitious fossil fuel replacement targets drive the expansion of biofuel production and its increasing appetite for agricultural crops, which lead to some confused conclusions on the relationships among crude oil, corn and biofuel price volatilities. Therefore, this study focuses on the linkage of crude oil prices, biofuel production and grain prices within the context of China as an example of a developing country.

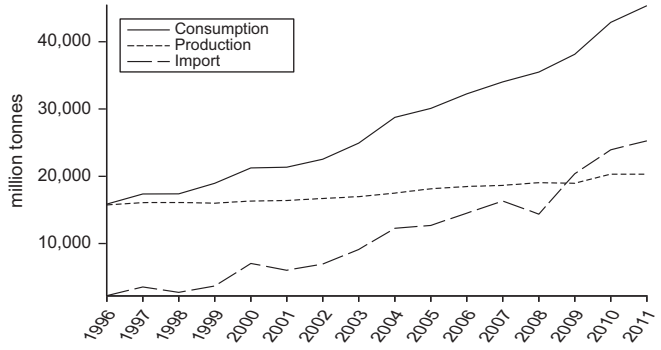

Fig. 1. Crude oil consumption, production and import in China between 1996 and 2011.
Data source: National Bureau of Statistics of China.

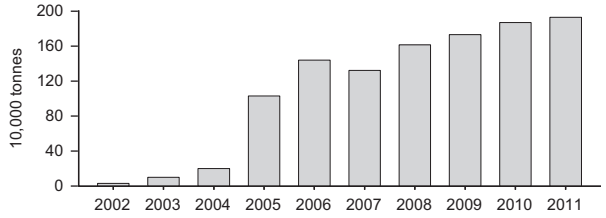

Fig. 2. Fuel ethanol production in China between 2002 and 2011.
Source: CCIEA.

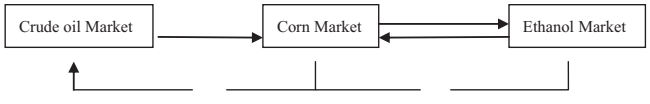

Fig. 3. Volatility spillovers model.

2. Literature Review

Complicating price discovery and representing the risk to economic agents, price volatility has long been recognized by economists as an important economic phenomenon (Buguk, Hudson and Terry, 2003). Ample evidence suggests that price volatility is important in agricultural commodities (Goodwin and Schnepf, 2000), but does volatilty in one market necessarily lead to volatility in other markets? The answer to this question has important policy implications. If volatility does spill over through market channels, policy changes in some markets that alter price volatility will have impacts on price volatility through market chains. These spillovers will then need to be considered in public policy decisions (Buguk, Hudson and Terry, 2003). Volatility spillovers have been frequently analyzed in financial markets under the name "volatility transmission" (Aspergis and Rezitis, 2001; Fang, Lin and Lee, 2007; Dean, Faff and Loudon, 2010); however, much less attention has been paid to volatility spillovers between agricultural and energy markets.

The relation between crude oil, corn and ethanol prices is not conclusive and varies at different times and in different countries. Du, Yu and Hayes (2011) assess factors that potentially influence the volatility of crude oil prices and the possible linkage between this volatility and agricultural commodity markets, finding that speculation, scalping and petroleum inventories are factors that can explain the volatility of crude oil prices. They split the data into two subsamples from the year of 2006, concluding that there was a much tighter linkage between crude oil and agriculture commodity markets in the second period. Similarly, Wu et al. (2011) found evidence of significant spillovers from crude oil prices to corn cash and futures prices in the U.S. They also found that when the ethanol-gasoline consumption ratio exceeded a critical level, crude oil prices transmitted positive volatility spillovers into corn prices and movements in corn prices were more energy-driven.

Tyner (2010) addressed the evolving link between energy and agricultural markets, finding that prior to 2005, there was little correlation between energy and agricultural prices. In 2006–2008, with the ethanol boom in the United States, there emerged a strong link between crude oil, gasoline and corn prices and a weaker link between ethanol and corn prices. However, in late 2008 and 2009, ethanol became priced more on corn, as the breakeven corn price helped drive the ethanol market. Serra (2011) employed the parametric BEKK model to evaluate volatility spillovers between crude oil, ethanol and sugar prices in Brazil. The results suggest that crude oil and sugar market shocks lead to an increase in ethanol price volatility and that ethanol price volatility increases as a response to increased sugar price volatility.

Barrera, Mallory and Garcia (2011) analyzed volatility spillovers from energy to agricultural markets in the U.S., and the results suggest that spillovers from crude oil to corn and ethanol markets are similar in magnitude over time and are particularly large during periods of high turbulence in the crude oil market. Volatility spillovers between corn and ethanol also exist, but primarily from the corn market to the ethanol market. The findings provide clear evidence of the stronger linkages between corn and ethanol that have been created forged the biofuel era. Gardebroek and Hernandez (2012) examined volatility transmission in oil, ethanol and corn prices in the United States between 1997 and 2011. The estimation results indicate a higher interaction between ethanol and corn markets in recent years, particularly