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Smooth volatility shifts and spillovers in U.S. crude oil and corn futures markets

Pavel Teterin, Robert Brooks*, Walter Enders

The University of Alabama, Culverhouse College of Commerce, 200 Alston Hall, Box 870224, Tuscaloosa, AL 35487, United States

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ABSTRACT

Recent developments in biofuel technologies have resulted in heightened linkages between the petroleum and agricultural sectors. As such, a large price and/or volatility shift experienced in one sector is now more likely to spill-over into the other. In trying to capture the interrelations present in the two markets, we take seriously the importance of properly modeling smooth structural shifts. We incorporate trigonometric functions into a multivariate GARCH model of crude and corn futures prices in order to obtain the empirical volatility response functions and the time-varying correlation coefficient. Although both short-term and long-term futures exhibit shifts in the mean and volatility, volatility shifts do not manifest themselves in the same manner for different maturities. This indicates that the term structure of futures volatility changes over time.

1. Introduction

The recent history of petroleum and agricultural commodity prices is replete with large fluctuations accompanied by sizable changes in their conditional volatilities. Sumner (2009) and Wright (2011) indicate that from 2006 through mid-2008 grains experienced one of the largest percentage price increases in history and that the volatility increases were sustained. For example, corn cash prices rose from $1.87 at the end of 2005 to $5.35 in August 2008. The price reached a maximum of $7.13 in 2013 only to fall to $3.53 by the end of 2015. Similarly, West Texas Intermediate spot prices fluctuated around $55 per barrel in 2005, rose to $145 in July 2008, and began a steady decent to $37 per barrel by the end of 2015. The co-movements between corn and oil futures prices can be seen in Fig. 1. It appears that the two prices often move together and that both volatilities are far larger in the latter third of the sample than during the 1990s.

Papers such as Hertel and Beckman (2011), Tyner (2010), and Muhammad and Kebede (2009) argue that the increased reliance on biofuels (particularly on ethanol) is a key factor contributing to the increased linkages between the grain and petroleum markets. As part of the Energy Policy Act of 2005, the Renewable Fuel Standard (RFS) requires that an increasing

* Corresponding author.
E-mail addresses: pteterin@crimson.ua.edu (P. Teterin), rbrooks@cba.ua.edu (R. Brooks), wenders@cba.ua.edu (W. Enders).

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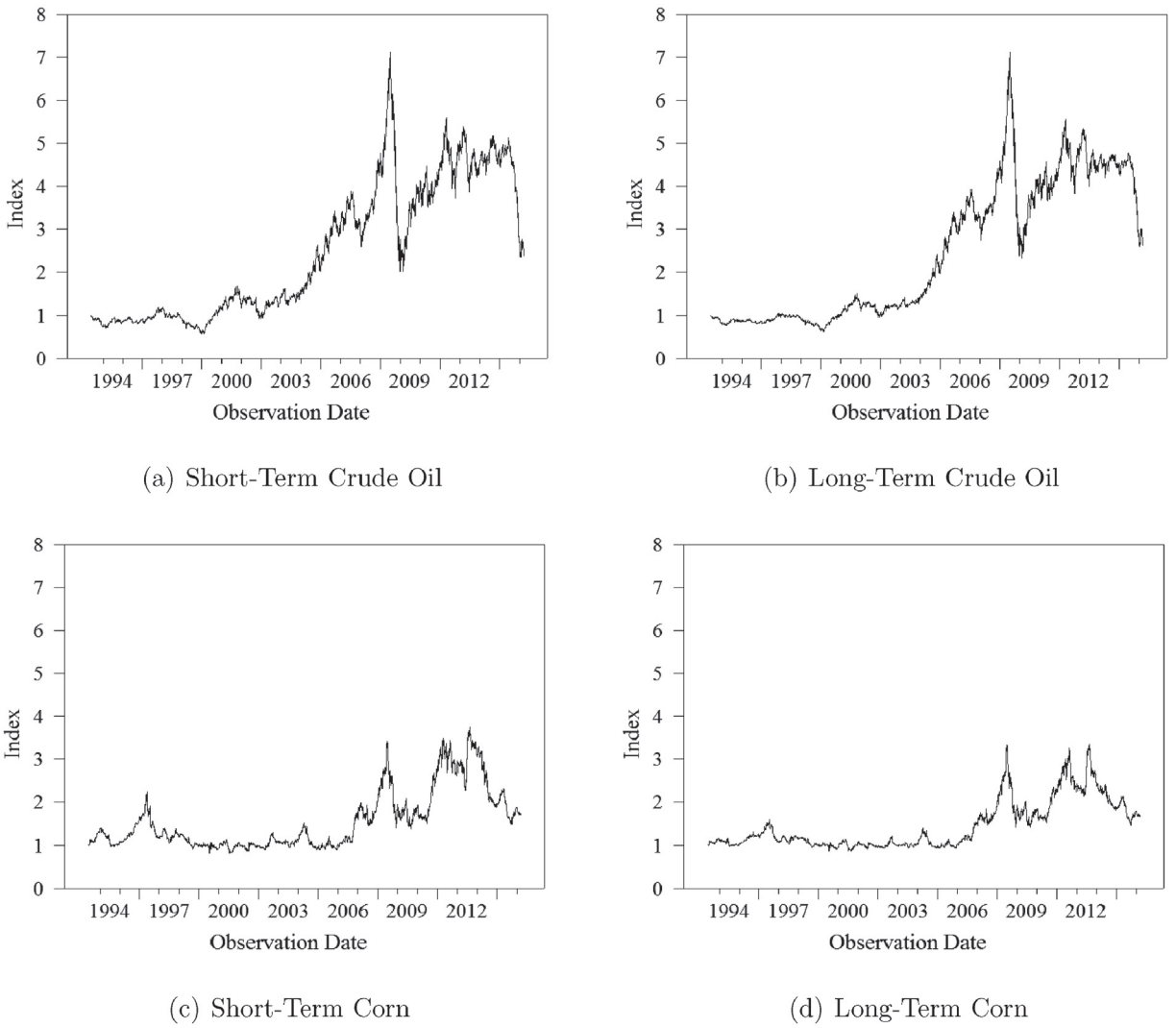

Fig. 1. Futures settlement prices. Panels (a) through (d) present the evolution of short-term and long-term corn and crude oil futures settlement prices throughout our sample period. In each panel, the futures prices are normalized by the price of the contract on June 1, 1993, and the resulting index is plotted on the vertical axis.

volume of renewable fuels be blended into all gasoline sold in the United States. The RFS required that four billion gallons of renewal fuels be blended into gasoline in 2006. The number rose to nine billion gallons in 2008 and is mandated to rise to 36 billion gallons by 2022. Moreover, as pointed out by Wetzstein and Wetzstein (2011), U.S. biofuel refining receives a federal tax credit of $0.45 per gallon along with various state subsidies combined with a $0.54 per gallon U.S. ethanol tariff. As a result, in 2011 over 40% of the U.S. corn crop was used in ethanol production.

In addition to increased biofuel production, researchers have offered additional explanations for these recent shifts in commodity prices and the accompanying volatility increases. Enders and Holt (2012) suggest that rapid income growth in emerging economies, specifically the so-called BRIC (Brazil, Russia, India, and China) countries, is one of the primary drivers of the price boom, citing increased demand for both agricultural and energy products. Trujillo-Barrera et al. (2012) argue that underinvestment in agriculture, low inventory levels, supply shocks in key producing regions, fiscal expansion and lax monetary policy in many countries, as well as a depreciation of the U.S. dollar, have also contributed to increased commodity price volatility.

In contrast, a number of authors have argued that the relationship between the two prices is not especially tight. For example, Myers et al. (2014) use common trend-cycle decompositions and find that the co-movements between energy and agricultural feedstock prices tend to dissipate in the long-run. Similarly, Wetzstein and Wetzstein (2011) contend that a strong connection between oil and agricultural prices is a "myth." Their reasoning is that the creation of biofuel capacity entails adjustment costs, non-reversibilities, and uncertainties. As such, biofuel production is not likely to be highly responsive to short-run oil-price changes. In the same vein, papers such as Tyner (2010), Hertel and Beckman (2011), Saghaian (2010) and Zhang et al. (2010) find that changes in government policy and/or non-petroleum input price changes often govern large movements in grain prices.