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Investigating the price discovery and risk transfer functions in the crude oil and gasoline futures markets: Some empirical evidence

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HIGHLIGHTS

- The futures performs price discovery better in both crude and gasoline markets.
- The gasoline contributes more to price discovery in its interaction with crude.
- Crude does risk transfer better than gasoline in their respective futures markets.
- The risk transfer between crude oil and gasoline markets does not function well.
- The recent financial crisis does not impact the price discovery and risk transfer.

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ABSTRACT

This paper empirically investigates the functions of price discovery and risk transfer in crude oil and gasoline futures markets using some econometric models. And the results indicate that, first, 95.71% and 59.41% of the price discovery function is performed by futures in crude oil and gasoline markets respectively during the sample period, implying the greater contribution of the futures markets compared with that of the spot markets. Meanwhile, the gasoline futures price makes 85.71% contribution to price discovery in its interaction with crude oil futures price. Second, crude oil futures price performs the risk transfer function much better than gasoline futures price in interactions with their respective spot prices. And the risk transfer function between crude oil and gasoline futures markets is not well performed. Finally, the recent financial crisis has not significantly influenced the price discovery and risk transfer functions between crude oil and gasoline futures markets.

1. Introduction

In the past few years, international crude oil price has experienced extreme volatility due to a confluence of numerous risk factors, which has led to large uncertainties for oil price forecast and dramatic market risk for investors. Consequently, the pricing mechanism in international crude oil market has become a hot topic [1,2].

In fact, the international crude oil price shocked all the way up from about 30 dollars per barrel in 2003 to more than 100 dollars per barrel in 2008, driven by the stable growth of world economy, US dollar depreciation, geopolitical events in the Middle East and North Africa, speculation of funds and so on, and even reached as high as 145 dollars per barrel in the middle of 2008. Subsequently, oil price faced sharp collapse in the second half of 2008, as a result of the severe financial crisis and economic recession caused by American subprime crisis. The crude oil price plummeted from the peak to just 33 dollars per barrel in late 2008, down nearly 80%. Afterwards, as world economy gradually recovers from the financial crisis, especially due to the huge contribution of emerging economies, global oil demand has been inching up, which causes oil price to rebound and rise through 100 dollars per barrel again at the end of 2011. It should be noted that the sharp fluctuation of international oil price has produced tremendous uncertainties for oil price forecasting, oil resource investment and oil market trading. Under this circumstance, how to reasonably determine the price of oil and effectively avoid the oil market risks has become one of the key concerns of related investors and researchers.

Currently, it has been universally acknowledged that oil futures market has played an important role in oil pricing and risk avoidance. And in a general way, price discovery and risk transfer are considered to be the two major functions of a futures market. As for the oil market, price discovery often emphasizes the use of oil

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futures price for pricing spot price [3,4]; put another way, the oil futures price may lead the movement of spot price. And risk transfer or hedging function often denotes that hedgers in oil market use oil futures contracts to shift price risk to others [3].

In addition, due to the close relationship between crude oil and gasoline products, investigating the interactive mechanism of the two markets has attracted much attention. As we know, crude oil is mainly refined into gasoline, diesel, kerosene and other oil products, which are the most direct fuel of modern vehicles. In particular, there exists close linkage between gasoline and people's daily life, and the change of gasoline price has large influence on people's living cost. Therefore, in this paper, we also extend the connotation of price discovery and risk transfer functions to investigate how the crude oil and gasoline markets may lead or lag each other and to measure the arbitrage risk between these two markets. The research results may provide some references for price forecasting and risk avoidance in both crude oil and gasoline markets.

The remainder of the paper proceeds as follows. Section 2 briefly reviews the existing related literature. Section 3 presents the empirical study methodologies and data definitions. Section 4 provides the empirical results and discussion. Finally, Section 5 puts forward some concluding remarks.

2. Literature review

Up to now, a number of empirical studies have investigated the linkage of crude oil spot and futures prices and the transmission mechanism of crude oil and gasoline prices, using some econometric models such as cointegration theory and Granger causality test. However, the conclusions vary a lot due to the differences in market categories, sample periods, data frequency and econometric models. We may briefly review the related literature as follows and summarize some key challenges currently.

First, as for the relationship between crude oil futures and spot prices, existing literature has a great deal of discussion and basically has similar viewpoints, i.e., they have long-run equilibrium interaction or close correlation. For instance, Maslyuk and Smyth [5] examine the relationship between crude oil futures and spot prices for the US WTI (West Texas Intermediate) and the UK Brent crude oil from January 1991 to November 1998 using a residual-based Gregory–Hansen cointegration methodology which allows for one structural break in the cointegrating vector, and find that crude oil futures and spot prices of the same grade as well as those of different grades are cointegrated respectively. Chen and Zeng [6] discuss the relationship of Brent crude oil spot and futures prices during the financial crisis period of 2007–2009, and the empirical results indicate that both crude oil futures and spot prices are stochastic unit root series and they have stochastic cointegration relationship. Zhang and Ding [7] and Liu et al. [8] validate the long-run equilibrium relationship between crude oil futures and spot prices using some linear and nonlinear models respectively. Cheng et al. [9] test whether crude oil futures price is the unbiased prediction to spot price, and find that only short-run futures (3 months maturity) price can accurately forecast spot price in 3 months later after 2004. Both Wang et al. [10] and Liu and Wan [11] state that WTI crude oil futures and spot prices and volatilities are cross-correlated in the long run. And Liu and Wan [11] further indicate that the exceedance correlations between the futures and spot price returns are overall symmetric, but some occasional events can induce significant asymmetries of the exceedance correlations. Recently, through modeling the relationship between WTI futures and spot prices as a cointegration relationship, Silvério and Szklo [12] empirically measure the time-varying contribution of futures market to price discovery process in WTI spot market using the Kalman filter technique. They find that the contribution of WTI futures market has been increasing, especially from 2003 to 2008 and then again after the start of 2009, evidencing the growing importance of factors particular to the financial markets in determining oil prices in recent years.

However, there is no consensus for the causal linkages between crude oil futures and spot prices in existing literature. For instance, Silvapulle and Moosa [13] analyze the linear and nonlinear causality between WTI crude oil futures and spot prices during 1985–1996, and reveal that crude oil futures price may linearly lead spot price in a uni-directional way, but they may have bi-directional nonlinear causality. Bekiros and Diks [14] also investigate the linear and nonlinear causality between WTI crude oil futures and spot prices of two sample periods from 1991 to 2007, i.e., October 1991–October 1999 and November 1999–October 2007, and find that there exists bi-directional linear causality between crude oil futures and spot prices in both periods, whereas there exists only uni-directional nonlinear causality in the second period, which is in contrast to the results of Silvapulle and Moosa [13]. Huang et al. [15] explore the WTI crude oil market from 1986 to 2007 with a multivariate threshold regression approach, and the results show that only when the spot price is larger than the futures price and their basis is less than a certain threshold value, as well as, when the futures price is larger than the spot price and their basis is more than a certain threshold value, may there exist at least one causal linkage between crude oil futures and spot prices; and no causality can be found in any other situations or directions. Kaufmann and Ullman [16] examine the causality among crude oil prices from North America, Europe, Africa and the Middle East in both futures and spot markets, and the results reveal that innovations first appear in spot prices for Dubai-Fateh and spread to other futures and spot prices, while other innovations first appear in the far month futures contract for WTI and then spread to other exchanges and contracts. Lee and Zeng [17] revisit the interaction between WTI crude oil futures and spot prices from 1986 to 2009 with the quantile cointegration approach and find that the cointegration relationship and causality between crude oil futures and spot prices appear significantly different according to the futures contract maturities and the performance of spot markets, and bi-direction causality can only be found between crude oil spot price and 1-month futures contract price. In a word, there still exist different arguments about the causality of crude oil futures and spot prices up to now, which should be investigated further.

Second, many studies have emerged regarding the price discovery and risk transfer functions of crude oil futures market [3,18,19]. In particular in recent years, a number of diverse research methods and perspectives have arisen for this issue. For instance, Gülen [20] and Yu et al. [21] analyze the market efficiency of WTI and Brent crude oil futures market respectively, and find that crude oil futures price does have price discovery function. With the information share (IS) model, Wang and Zhang [22] find that crude oil futures market performs 54.27% of price discovery function during the sample period from 1983 to 2004, which indicates that futures price plays the dominant role in crude oil price change. Chen and Zheng [23] explore the relationship between crude oil futures and spot prices, and state that, in most cases, the futures price is not an unbiased estimate of the spot price in the future; conversely, the price discovery function of futures market should be defined as the lead–lag relationship between current futures and spot prices. And Chen and Wang [24] consider international crude oil futures market has significant price discovery and hedging functions, and advocate that China should launch crude oil futures market soon. However, comparatively, there is little literature quantitatively analyzing the risk transfer function of crude oil futures market up to now.