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Linear and non-linear Granger causality between oil spot and futures prices: A wavelet based test



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ABSTRACT

This study is the first attempt to investigate both the linear and non-linear Granger causality between wavelet transformed spot and futures oil prices. Our findings consistently indicate bidirectional causality between the spot and futures oil markets at different time scales, under linear and non-linear causality assumptions, and also during the recent financial crisis. Our results tend to shed further light on the ongoing controversy over the relative price discovery role played by spot market as opposed to futures market in oil price fluctuations, especially during periods of high uncertainty.

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1. Introduction

The causality between oil spot and futures markets is and has been a debatable issue. Theoretical and empirical attempts to study the relationship between oil spot and futures show no resolve of the

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causality direction. This ambiguity encourages policy debate on the cause of fluctuations in oil prices.¹ Speculation in the futures market is argued to be the main cause of oil price fluctuations, especially during the recent financial crisis. As speculators use the futures market to make bets on oil prices, they increase the volatility in oil prices. If high fluctuations in oil prices originate from futures market as opposed to spot market, then speculation activities are likely to be a cause of the fluctuations (Kaufmann and Ullman (2009)).

In this study we try to determine the direction of causality between spot and futures oil markets. Under the assumption that speculation activities occur more in futures market, a unidirectional causality that runs from futures to spot provides the necessary, but perhaps insufficient,² condition for speculations to be the main cause of fluctuations in oil prices. It is a necessary condition because without it, there is no special role of futures market, and thus speculation, in price discovery. Additionally, finding a unidirectional causality from spot to futures prices or finding bidirectional causality will indicate that speculation (at best) is as likely to affect oil prices as any other fundamental factor.

Our causality analysis controls for important methodological issues that may impact the causality test results. In particular, we transform our time series into frequency domain without losing time domain information using wavelet method to avoid the need to assume a certain parametric models of the series and account for time-dependent volatility, time-dependent covariance, and structural breaks which is shown to exist in oil futures and spot (Kawamoto and Hamori (2010), Switzer and El-Khoury(2007), Cortazar and Naranjo (2006), Fong and See (2003), and Low et al. (2002)). In addition, we employ linear and non-linear causality tests to investigate the direction of causality. We use the modified Baek and Brock (1992) causality test as in Hiemstra and Jones (1994) to account for non-linearity that inhibits the oil futures and spot series (Chen and Lin (2004) and Bekiros and Diks (2008)).

Our results reveal causality in both directions with no market necessarily dominating the other in terms of price discovery. This bidirectional causality lasts even for longer time period when we employ the non-linear causality test and does not change when volatility heightened, especially during the recent financial crisis. Our results indicate that causality moves from one direction to another over time, and thus speculators, who trade in oil futures market, have no systematic impact on oil spot prices. Our results also suggest that spot market can have a similar impact on futures market.

¹ In 2008, oil prices reached \$147/b from around \$60/b in 2007. This increase raises the concerns of policy makers in energy consuming and producing countries alike. On March 30th, 2010, the OPEC Secretary General, says " ... the price swings in oil markets saw days when the price of crude oil fluctuated by as much as \$16/b. This cannot be justified by fundamentals. It was obvious and clear that it was speculative activity" Source: http://www.opec.org/opec_web/en/press_room/1712.htm This view from OPEC is also shared by other agencies. For example, a report published by the United Nations Conference on Trade and Development states that, "although there is no conclusive evidence of the extent to which speculation is contributing to rising commodity prices so far, there can be little doubt that it has significantly amplified price movements originally caused by changes in market fundamentals" source: *Commodity Prices, Capital Flows, and the Financing of Investment, Trade and Development Report 2008, September 2008*, p.22. In addition, the International Monetary Fund released a report in 2008 stating that, "in summary, it appears that speculation has played a significant role in the run-up in oil prices as the U.S. dollar has weakened and investors have looked for a hedge in oil futures" source: *Regional Economic Outlook, Middle East and Central Asia, International Monetary Fund World Economic and Financial Survey, May 2008*, p. 27. Similarly, the former Federal Reserve Board Chairman Alan Greenspan has said "financial speculation did play a significant part in the rapid increase in oil prices" source: *Financial Times, August 11, 2008*. In trying to find out the causes of such increase in oil prices, the Commodity Futures Trading Commission (CFTC) formed an Interagency Task Force on Commodity Markets to provide a preliminary assessment of fundamental and market factors affecting the crude oil market. The Task Force's analysis reached the conclusion that the increase in oil prices between January 2003 and June 2008 is largely due to fundamental supply and demand factors with no systematic effect of speculative activity. Such a conclusion coincides with the CFTC's long held view that speculators provide liquidity rather than instability. Although, this conclusion is based on scientific findings, it draws a lot of controversy over its motivation, data, and methodology. According to Bart Chilton, a Commissioner at the CFTC, "The Interagency Task Force released an Interim Report on July 22nd that contained statements about speculative activity in the oil markets. Those statements were at best premature given that key information, such as the type of data on which the CFTC bases its instant recommendations, was not available for analysis by the Interagency Task Force ... until we have a comprehensive, unbiased study of this issue, we should not be making declarative judgments as to causation or effect".

² Finding a unidirectional causality from futures to spot, however, may not provide sufficient evidence on the role of speculators as futures market can drive spot market based on future outlook of fundamental factors or based on price information gained from non-speculative trades in the futures market.

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