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Do net positions in the futures market cause spot prices of crude oil?

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ABSTRACT

The last decade has witnessed sharp increases in the price of crude oil. There are two possible explanations for these increases: dramatic increases in financial firms' position in the oil futures market and recent increases in oil prices from changes in economic fundamentals. This paper examines the causal relationship between the net financial position and the crude oil price by using three types of Granger non-causality tests: the classical Granger non-causality test, a robust Granger non-causality test and a Granger non-causality test in quantiles. The empirical results provide some evidence of causality from the net financial position to the spot price of crude oil. In addition, futures prices serve as a transmission mechanism underlying the causal relationship between the net financial position and the crude oil price.

1. Introduction

The price of crude oil has increased sharply since 2003, peaking at $142 per barrel in July 2008. In addition, the total value of commodity index funds by institutional investors increased dramatically from approximately $13 billion at the end of 2003 to approximately $200 billion in July 2008. Further, the amount of investment in NYMEX crude oil was approximately one third of the total commodity index investment in the U.S. market in June 2008 (Commodity Futures Trading Commission, 2008). As a result, there has been an ongoing debate about whether the recent increase in the price of crude oil is due to the sharp increase in speculative position-taking activity in the oil derivatives market. Some studies have reported that the speculative position does not cause sharp increases in the price of crude oil and that macroeconomic fundamentals such as oil demand from emerging economies and interest rates do matter in the price of crude oil (e.g., Alquist and Gervais, 2011; Hamilton, 2009; Interagency Task Force on Commodity Markets, 2008; Till, 2009). On the other hand, Cho (2008), Masters (2008), Khan (2009) and Singleton (2011) argue that speculative pressure exists in the futures market and increases the crude oil price.

This paper examines the causal relationship between the net financial position in the futures market and the price of crude oil by using three types of Granger non-causality tests: the classical Granger non-causality test, a robust Granger non-causality test, and a Granger non-causality test in quantiles. Interagency Task Force on Commodity Markets (2008) and Alquist and Gervais (2011) apply the classical Granger non-causality test (Granger, 1969) by using return series data, i.e., the first difference of the log of oil prices and changes in the variable for speculation, to ensure the stationarity of time series. Here return series data are used because the classical Granger non-causality test is valid only for stationary time series. However, the original debate is about the causal relationship between the oil price and the speculation position. In addition, testing causality by using the conditional mean function may not be appropriate because return series are highly volatile. That is, a non-causality test based on the conditional mean is not robust. To address such problems for the classical Granger non-causality test, this paper uses the robust Granger non-causality test procedure in Toda and Yamamoto (1995), which is robust to non-stationarity and cointegrating relationships between variables. The main advantage of this test procedure is that there is no need to take the first difference to apply the Granger non-causality test. However, the classical or robust Granger non-causality test is nothing but a test of the non-causality hypothesis in the conditional mean based on a linear model. These tests are limited in that they do not consider different locations or scales of the conditional distribution. For a complete understanding of the causal relationship between the spot price and the net position in the crude oil market, this paper considers the Granger non-causality test in quantiles in Chuang et al. (2009). Singleton (2011) mentions that participants in spot and futures markets (or those refining or holding crude oil inventories) are not necessarily representative agents. Because there are heterogeneous agents in the market, their beliefs about future market conditions vary, which implies some disagreement about future oil prices and financial positions between market participants. In this regard, causal relationships with respect to different levels of oil prices or financial positions in the futures market provide important insights into the question whether

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financial net positions predict price of crude oil when market agents have heterogeneous beliefs. Based on the Granger non-causality test in quantiles, this paper investigates the causality from the net position to the oil price at different levels of oil prices.

For an empirical analysis, the paper uses weekly data on the price of crude oil and the financial position from February 6, 1996, to March 20, 2012. Here we conduct three types of Granger non-causality tests with the whole sample period and two sub-sample periods. For the whole sample period, the null hypothesis of Granger non-causality from the net position of noncommercial traders to the oil price is rejected. However, the results of the Granger non-causality test for the two subperiods are mixed. For the first subperiod (1996–2003), the null hypothesis is not rejected regardless of the type of Granger non-causality test. However, it is rejected for the second subperiod (2004–2012) which both academic and public have the most interest.

The empirical results for the classical Granger non-causality tests are consistent with the findings of Alquist and Gervais (2011) and Büyüksahin and Harris (2011), who provide evidence of Granger causality from the oil price to the net position for noncommercial firms, for the whole sample period as well as for the first subperiod. These results imply that traders in the crude oil futures market are "trend followers" who take positions based on price expectations over a specific period of time (see Büyüksahin and Harris, 2011). However, the results for the robust Granger non-causality test provide no evidence of causality from the oil price to the speculator's net position. In addition, from the perspective of conditional quantiles, traders are "trend followers" only when the level of the net position is high for the whole sample period and the second subperiod.

These results highlight the importance of identifying the factors serving as the transmission mechanism underlying the causal relationship. For this, this paper uses functional coefficient regression models in which the futures price is taken as the transmission mechanism. The results show that the strength of causality from the net position of noncommercial firms to the spot price increases when futures price increases, which indicates that the futures price can be treated as a transmission mechanism underlying the causal relationship. In addition, when the model coefficients are allowed to vary over time, the sign of causality from the net position to the spot price is positive (negative) for noncommercial (commercial) firms.

The rest of this paper is organized as follows: Section 2 presents the econometric methodology for the Granger non-causality tests. Section 3 provides the descriptive statistics for the data, and Section 4 presents the empirical results. Section 5 discusses the transmission mechanism underlying the causal relationship, and Section 6 concludes with a summary.

2. Econometric methodologies

2.1. Granger non-causality test

Granger (1969) proposes a simple but powerful method for testing the causal relationship between two random variables. The random variable x does not Granger-cause the random variable y if

$$F_{y_t}(z|(\mathcal{Y},\mathcal{X})_{t-1}) = F_{y_t}(z|\mathcal{Y}_{t-1}), \quad \forall z \in \mathbb{R}, \tag{2.1}$$

holds, where $F_{y_t}(\cdot|\mathcal{F})$ is the conditional distribution of y_t, and $(\mathcal{Y},\mathcal{X})_{t-1}$ denotes the information set generated by y_i and x_i up to time $t-1$. The variable x said to Granger-cause y if Eq. (2.1) fails to hold. We can consider a simpler necessary condition for Eq. (2.1) as follows:

$$\mathbb{E}(y_t|(\mathcal{Y},\mathcal{X})_{t-1}) = \mathbb{E}(y_t|\mathcal{Y}_{t-1}), \quad \text{a.s.}, \tag{2.2}$$

where $\mathbb{E}(y_t|\mathcal{F})$ is the mean of $F_{y_t}(\cdot|\cdot)$. Here x_t does not Granger-cause y_t in mean if Eq. (2.2) holds. Most empirical studies check whether Eq. (2.2) holds when analyzing the causal relationship between x_t and y_t. To address this issue empirically, we can use the following bivariate autoregressive model to test the causal relationship in mean between stationary time series Δx_t and Δy_t[2]:

$$\Delta y_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i \Delta y_{t-i} + \sum_{i=1}^{p} \beta_i \Delta x_{t-i} + \epsilon_{y,t}, \tag{2.3}$$

$$\Delta x_t = \phi_0 + \sum_{i=1}^{p} \phi_i \Delta x_{t-i} + \sum_{i=1}^{p} \varphi_i \Delta y_{t-i} + \epsilon_{x,t}, \tag{2.4}$$

where $\epsilon_t = (\epsilon_{y,t}, \epsilon_{x,t})'$ denotes a vector of the i.i.d. random disturbance. The null hypothesis of Granger non-causality in mean from Δx_t to Δy_t is rejected if the coefficients of the lagged Δx_t in Eq. (2.3), that is, β_1, β_2, ⋯, β_p, are jointly different from zero. Similarly, if the coefficients of Δy_{t-1}, ⋯, Δy_{t-p} in Eq. (2.4) are significantly different from zero, then we can conclude that Δy_t Granger causes Δx_t in mean. We can test the null hypothesis by using the F-test or the Wald test.

2.2. Robust Granger non-causality test

The classical Granger non-causality test is useful for checking causal relationships between many variables. However, the time series variables in model (2.2) should be stationary. This condition is crucial because the presence of a unit root changes all usual asymptotic properties of estimators. In addition, in many cases, it is hard to guarantee that all considered series are stationary because it is well known that the power of usual tests for a unit root is very low. When the considered time series variable has a unit root, the usual test statistics such as the F-test, the Wald test, and the LR test do not have an asymptotic χ^2 distribution under the null hypothesis. This implies that we cannot conduct a Granger non-causality test by using the VAR model when some variables have a unit root. Therefore, we need to analyze the causal relationship by using first-difference series, which yields more limited information than the level series. Toda and Phillips (1993) and Toda and Yamamoto (1995) propose a robust inference method in the sense that the usual test statistics in the VAR system follow an asymptotic χ^2 distribution under the null hypothesis even when variables are integrated or cointegrated of some arbitrary order.[3] They consider the lag truncation order $p+d$ in a bivariate autoregressive model using level variables, where d denotes the maximum order of integration that the considered time series x_t and y_t can have. Then the model can be expressed as follows:

$$y_t = \alpha_0 + \sum_{i=1}^{p+d} \alpha_i y_{t-i} + \sum_{i=1}^{p+d} \beta_i x_{t-i} + \epsilon_{y,t}, \tag{2.5}$$

$$x_t = \phi_0 + \sum_{i=1}^{p+d} \phi_i x_{t-i} + \sum_{i=1}^{p+d} \varphi_i y_{t-i} + \epsilon_{x,t}, \tag{2.6}$$

where p can be chosen using the usual lag truncation selection rules. Toda and Yamamoto (1995) show that linear or nonlinear restrictions on the first p coefficients $(4 \times p)$ can be tested using standard asymptotic theory. That is, we can conduct the usual Granger non-causality test

[2] We use Δx_t and Δy_t in the bivariate autoregressive model because x_t and y_t are assumed to have a unit root. This, of course, can be tested before conducting a Granger non-causality test. When x_t and y_t are stationary, there is no need to take the first-difference.

[3] For more information, see Zapata and Rambaldi (2001), Mosconi and Giannini (1992) and Dolado and Lütkepohl (1996).