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Price discount, inventories and the distortion of WTI benchmark

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ABSTRACT

Applying a rolling estimation to the Hasbrouck information share model, this study investigates the changing status of WTI benchmark over time. Results show the ability of WTI in reflecting market conditions decreases sharply, and WTI's efficiency in processing information has been surpassed by Brent's since the second half of 2004. In the short run, the WTI distortion is related to its price discount problem, but the distortion cannot be indicated by contangos. In the long run, WTI's price discount problem coexists with a positive forward curve and both have harmed the price discovery role of WTI. The rising inventories in Cushing significantly deteriorate WTI's ability in serving as a world benchmark.

1. Introduction

The usefulness of the West Texas Intermediate (WTI) benchmark in pricing the crude oils has been increasingly debated in the world oil market because of the frequent dislocations of WTI from other major benchmarks. From early 2006, WTI has been occasionally priced at large discounts to Brent and other grades of oils (including Dubai). These large discounts violate the traditional pricing principles that command a premium on WTI to reflect the better quality of oil delivered, and to account for the cost of shipping crude oil across the Atlantic.[1] Doubts on the benchmark status of WTI are expressed by Bentzen (2007), Hammoudeh et al. (2008) and Kaufmann and Ullman (2009) who argue for the inability of WTI to reflect market conditions. But these arguments contradict the results put forth by Gülen (1999), Brunetti and Gilbert (2000), and Lin and Tamvakis (2001, 2004).

Market participants often attribute WTI dislocations to the logistic constraints at Cushing, Oklahoma — a delivery and settlement point of WTI futures contract (Fattouh, 2007, 2009, 2010). The bottleneck in Cushing's ability to shift oils out of the region has sometimes caused a larger-than-expected build-up of crudes in Cushing. Rising crude oil stocks at Cushing depress WTI prices in both the physical and paper markets. In addition, a self-feeding 'reinforcing feedback' of local storage built-up is inflamed by exploiting the contango price arbitrage with a 'cash and carry' strategy. The reinforcing contango leads to a continuous decoupling of WTI from other U.S. and international crude grades, making WTI ineffective in hedging crude oil futures. Fattouh (2007) argues as a consequence that WTI is a 'broken benchmark'.

Although discussions regarding the appropriateness of using WTI as a pricing marker are intensively carried on the media,[2] little attention has been paid to the evidence relating the glut of Cushing's inventory to the inefficiency of WTI benchmark. This paper is going to prove the relation of inventory problem and dislocation of WTI, and to examine how the reference place of WTI changes over time. We apply the Hasbrouck

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[1] Although crude oil futures contracts traded on the New York Mercantile Exchange (NYMEX) are primarily based on the delivery of WTI crudes, the Brent Blend in London is also one of the grades acceptable for delivery of the NYMEX. The price differential between the two crudes should never exceed the costs of shipping Brent across the Atlantic (Schofield, 2007).

[2] It is reported in October, 2009 that the world's largest oil producer and exporter — Saudi Aramco announced it will drop WTI as the benchmark for pricing its oil for sale in the US market since 2010. But the advocates of WTI argue that WTI still can be a better reflection of world oil economies. Despite the daily production at Cushing has declined to 300,000 to 400,000 barrels, WTI contract is traded on the world's most liquid exchange — the NYMEX. Besides, the NYMEX allows multiple crude streams with similar quality to be delivered against WTI contracts. Therefore, a variety of domestic crudes, such as Low Sweet Mix, New Mexican Sweet, Oklahoma Sweet, and South Texas Sweet can be close substitutes for the crudes at Cushing. Some foreign crudes including UK Brent, Norwegian Oseberg blend, Nigerian Bonny Light, Nigerian Qua Iboe, and Colombian Cusiana can also be delivered with a certain cash discount or premium under the WTI principles (Schofield, 2007; Veazey, 2009).

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(1995) information share model to a rolling estimation process in order to analyze the relations between the benchmark status of WTI, the inventory accumulations in Cushing and WTI price discounts to Brent. Quantitative analyses are used to test the following hypotheses: (1) The WTI benchmark has been 'broken'. (2) The price disparity between WTI and Brent (i.e. the WTI discount problem) is a warning against using WTI benchmark. (3) The crude oil stocks in Cushing prevent WTI from serving as a benchmark for the world oil market.

Using Hasbrouck information share model to investigate the benchmark role of WTI is supported by Kaufmann and Ullman (2009) in which a benchmark is defined as the market from which the price changes first appear, and toward which the prices of other crude oils equilibrate. Since the information share given by the Hasbrouck model denotes one market's efficiency in reflecting relevant news for markets in a cointegrated system, the Hasbrouck (1995) information share model has been widely used in the literature to discuss market efficiency.[3] If one market is more information-efficient, it will get higher information share for reflecting a better ability in indicating future price changes. In a cointegrated system, the market with the highest information share acts as the price discovery center.

Empirically, evidence on the price discovery center (or equivalently, the benchmark) for world oil markets has not been drawn, yet. Earlier studies that dispute over the globalization/regionalization hypotheses tend to acknowledge the legitimacy of WTI rather than Brent in determining the world oil prices. Gülen (1997, 1999) indicates the benchmark role of WTI and Brent comes from the large progress in the futures markets respectively launched by the New York Mercantile Exchange (NYMEX) and the London International Petroleum Exchange (IPE, renamed as the IntercontinentalExchange/or the ICE later) in the 1980s. The largest trading volume on the NYMEX's crude oil contracts has in particular contributed WTI to be more relevant in pricing the crudes than Brent. Other researches that use GARCH-type models give similar conclusions. For example, Brunetti and Gilbert (2000) and Lin and Tamvakis (2001) demonstrate the WTI contracts can efficiently incorporate London's information into its price dynamics, and therefore suggest WTI is superior than Brent in leading the oil price.

However, recent studies that extend the investigation period beyond the year of 2000 express controversial opinions about the world oil pricing center, most of which overrule the position of WTI as a world benchmark. For example, Hammoudeh et al. (2008) indicate Dubai is more influential in directing the oil price dynamics than WTI and Brent. Bentzen (2007) highlights the increasing influence of OPEC on the prices of light crude oils. Kaufmann and Ullman (2009) find the world oil market is bi-centric. The first center is the spot market of Dubai-Fateh, and the other is the far month trading of WTI. Market innovations first appear in the two centers, and subsequently spread to other regions.

In this paper, the changes in the reference place of WTI are investigated by a rolling estimation over the period from October, 1991 to February, 2009. Our results show the ability of WTI in processing and reflecting market conditions decreases dramatically over time. Additionally, since the second half of 2004, the information share of WTI has been surpassed by that of Brent. The WTI distortion is highly related with the appearance of its price discount problems. The information share of WTI is significantly and negatively influenced by the increasing frequencies of WTI discount. The shape of a forward curve cannot explain WTI distortion in the short run. But in the medium and long terms, contango is entangled with discount problem and both indicate the failure of WTI benchmark. Since contango serves as a proxy of inventories, this last result is consistent with the conjectures of market participants that the increasing stocks in Cushing causes continuing discounts and contangos in WTI price, and explains the breakdowns in WTI benchmark (Fattouh, 2007, 2009).

The following section, Methodology, presents the Hasbrouck (1995) information share model and describes the empirical models used in this paper. Section 3 describes data used in this paper and offers preliminary analyses. Section 4 reports empirical results. Section 5 gives concluding remarks and provides a brief discussion of possible future investigations.

2. Methodology

Several approaches have been reported in the literature to identify the direction of information transmission across markets. Apart from the Granger cause analysis and multivariate GARCH models, the Hasbrouck information share model gives each market a measure – the information share – for describing their abilities in processing news, and therefore is a useful tool for ranking market efficiency. Tse (1999) notes the Hasbrouck model facilitates the quantification of the concept of price discovery.

2.1. The Hasbrouck information share model

The Hasbrouck model is based on a cointegrated system in which price series are driven by common factors. These common factors are considered to be the sources of permanent price movements. Each market's contribution to the variance of innovations to the common factor is tagged as the 'information share'. The market that has the highest information share is the price discovery center because it has the best ability in explaining the permanent innovation.

To calculate each market's information share, Hasbrouck (1995) inverts the n-variable VECM into a vector moving average (VMA) representation which has an integrated form as:

$$P_t = \iota\psi\left(\sum_{s=1}^{t} e_s\right) + \psi^*(L)e_t, \tag{1}$$

where P_t is a column vector of n price variables, ι is an $(n\times1)$ column vector of ones in the system. Vector ψ is a row vector with elements ψ_j $(j=1,\ldots,n)$. $\psi^*(L)$ is a matrix of polynomials in the lag operator L. e_t is a zero-mean vector of serially uncorrelated disturbances with covariance matrix of Ω. The sample size contains t observations.

Combing the row vector ψ with an innovation vector in a given period of t produces the first part of Eq. (1), ψe_t. Hasbrouck (1995) states that "[t]he increment ψe_t is the component of the price change that is permanently impounded into the security price and is presumably due to new information." The second part of Eq. (1), $\psi^*(L)e_t$ is the transitory component which does not have a permanent impact on price dynamics.

The focus of the model is the decomposition of the variance of the permanent component, $\mathrm{var}(\psi e_t)$ into proportions contributed by each price series. A market's information share is then defined as

$$S_j = \frac{(\psi M)_j^2}{\psi\Omega\psi'} \qquad j = 1, 2 \tag{2}$$

where M is a lower triangular matrix of the Cholesky factorization of Ω, such that $\Omega=MM'$. And $(\psi M)_j$ is the jth element of the row matrix ψM.[4] The cointegrated relation restricts the sum of information shares in the system to one, so we have $\sum_{j=1}^{n} S_j = 1$. Since the estimates of information share vary according to the orderings of the variables in the Cholesky factorizations,[5] Baillie et al. (2002) suggest the mean of the information shares from all orderings is a reasonable estimate.

[3] For example, Pascual et al. (2001) analyze five Spanish stocks cross-listed to the New York Stock Exchange (NYSE). Roope and Zurbruegg (2002) examine the competition between two similar index futures contracts traded on Singapore Exchange and the Taiwan Futures Exchange. Gramming et al. (2005) study 3 German stocks listed on the Frankfurt and the NYSE. Su and Chong (2007) apply the model to eight Chinese stocks cross-listed on the Stock Exchange of Hong Kong (SEHK) and NYSE. Kao and Wan (2009) use this model to discuss the information transmission between the natural gas markets across the Atlantic.

[4] We apply the Hasbrouck model to a two-variable system in this study. Number 1 represents the WTI market, and number 2 represents the Brent market.

[5] The Cholesky factorization maximizes the information share of the first price.