High Frequency Trading of Brent Crude Price

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Abstract - A review of high-frequency and pair trading on Brent crude oil is performed, followed by a proposal of empirical study. The oil market is faced with high levels of which makes it appropriate for this investigation. The objective is to investigate the literature on both high-frequency and pair trading and confirmed its predictive power as an investment tool. Our findings showed that although high-frequency trading had increased in the stock market but they are not significant in other commodity markets, due to its higher liquidity requirements.

I. INTRODUCTION

Many financial markets have abandoned human intermediation via floor trading or the telephone, replacing them with an electronic limit order book or another automated trading system (Jones 2013). This resulted in high frequency trading where competing markets improved market liquidity, reduced trading costs, and made stock prices more efficient. High-frequency trading (HFT) is the use of sophisticated technological tools and computer algorithms to rapidly trade securities. Proprietary trading strategies carried out by computers allowed traders to move in and out of positions in seconds or fractions of a second. As of 2009, empirical studies suggested that HFT firms accounted for 60-73% of all US equity trading volume.

The oil market is faced with high levels of volatility (Alizadeh & Nomikos, 2008) and a significant increase in crude oil price trading has been observed over the past decade through a range of instruments, including commodity index investment and the proliferation of commodity-based hedge funds (Cummins & Buca, 2011). With the advancement of new technology such as HFT, volatility is no longer simply feared, but it may represent a profitable opportunity. High-frequency trading (HFT) influenced crude oil price discovery and volatility spillover potentials (Lean, McAleer and Wong, 2010). A study on the impact of HFT on crude oil is important since crude oil is among the most important commodities in the world economy and has both direct and indirect pressure on the economy of different countries (Schultz and Swieringa, 2012). The dramatic price fluctuations in crude oil since 2003 have renewed interest in understanding the evolution of the real price of oil (Kilian & Murphy, 2013). There is much debate in policy circles about whether the surge in the real price of oil between 2003 and mid-2008 was caused by speculative trading in oil futures markets (Fattouh, Kilian and Mahadeva 2012). Issues and the processes of price discovery in oil markets and the drivers of oil prices in the short-run remain under-researched. While this topic is linked to the current debate on the role of speculation versus fundamentals in the determination of the oil price, it goes beyond the existing debates which have recently dominated policy agendas (Fattouh, 2011).

Oil prices volatility open up new trading opportunity which is suitable for pair trading (Chen & Hsu, 2012). Although oil may suggest a common product, it is in fact a heterogeneous product composed of parts of different kinds; having widely dissimilar elements or constituents. It varies in two crucial dimensions: substance and location (Büyükşahin, Lee, Moser & Robe, 2012). Dozens of physical benchmarks and associated derivatives have come into existence to reflect the differing crude oil qualities and trading conditions in various locations around the world. The most used benchmarks in international trade are Brent and WTI (Schultz and Swieringa, 2012).

‘Pairs trading’ create the opportunity for large profits from speculation on oil prices. Volatility can disrupt the normal relationship – or ‘correlation’ – between prices for pairs of assets, example between Brent and West Texas oil. Traders bet that those relationships will be restored pretty quickly.

“Pairs trading” is a investment strategy used to exploit financial markets that are out of equilibrium (Litterman, 2003). “Pairs trading” is a trading strategy consisting of a long position in one security and a short position in another security in a predetermined ratio. If the two securities are from the same financial sector (two oil companies), one may take this ratio to be unity. This ratio may be selected in such a way that the resulting portfolio is market neutral, a portfolio with zero beta to the market portfolio. This portfolio is often called a spread. Discussion of pairs trading can be found in Gatev et al. (2006) and Vidyamurthy (2004).

The purpose of this paper is to perform a literature review on crude oil trading, combining the HFT and pair trading strategies to capitalize on the increase volatility of crude oil.
We investigate the impact of higher volatility and high frequency trading and explore the potential of making trading gains from pair trading strategy. We discuss the matter and propose an empirical model to test our theories.

The research hypothesize that the dynamic parameter estimation is more appropriate in a long-term investment; that faster trading generates higher abnormal return; that the optimal thresholds for opening and closing positions are set near the mean of the spread; that transaction cost is a strong risk factor of high-frequency pairs trading; and that pairs trading tends to be consistent under extreme event if the pairs are highly correlated.

II. LITERATURE REVIEW

A. Crude Oil

The importance of crude oil within the modern economy is well appreciated. Unlike a pure financial asset, the crude oil market also has a “physical” dimension that should anchor prices in oil market fundamentals: crude oil is consumed, stored, and widely traded with millions of barrels being bought and sold every day at prices agreed by transacting parties. Thus, in principle, prices in the futures market, through the process of arbitrage, should eventually converge to the so-called “spot” prices in the physical markets.

There are several reasons for the volatility in oil price (Kilian & Murphy, 2012).

The surge in the real price of oil between 2003 and mid-2008 may have been caused by speculative trading in oil futures markets (Fattouch, Kilian and Mahadeva 2012) or the unexpected reductions in oil supplies. The unexpected reductions in oil supplies could be due to OPEC withholding oil supplies from the market or because global oil production had peaked, as predicted by the peak oil hypothesis (Fattouch, 2011). Another view is that this surge in the real price of oil was driven instead by unexpectedly strong economic growth in the global economy, in particular in emerging Asia (Kilian & Murphy, 2012).

B. Market Structure

Crude oil is an oligopolistic market (Griffin, 1985; Alhajji and Huettner, 2000; and Dees et al., 2003) and the long-term marginal cost is a small fraction of the price of oil, even when making considerable allowances for the future values of the resources used up today (“user costs”). To support high price levels, the excess supply is restricted by a cartel (Adelman, 1993). The market works in the following way: higher cost producers sell all they can produce, while low-cost producers satisfy the remainder of the demand at current prices and cut back production if needed. Adelman (1993). Saudi Arabia confirms the asymmetric behavior of the low-cost petroleum suppliers: the country restricts production in reaction to negative demand shocks but does not expand production in response to positive ones, in order to sustain high prices (De Santis, 2000).

Market pricing has dominated crude oil transactions since the mid-1980s, with long-term contracts pegged to the prices of key crude oil grades1. These prices are, themselves, typically constructed by price reporting agencies, who survey physical market participants for the prices of over-the-counter spot, forward and swap transactions or for indicative bid and ask prices. Financial derivative markets have grown alongside these benchmarks and facilitate both hedging as well as speculation unimpeded by the logistical concerns of physical delivery.

Since there are no short term substitutes for petroleum, changes in supply are also effective. Moreover, demand for crude oil is highly insensitive to price changes (Cooper, 2003).

1) Brent

The key benchmark for crude oil pricing in Europe is dated BFOE. While this benchmark is interchangeable referred to as dated Brent, the two technically differ. Specifically, Brent is the original name for oil from specific fields collected through a pipeline system that is connected to a terminal at Sullom Voe in the Shetland Islands. However, declining supplies from the original Brentfields have led to comingling with oil from the Ninian field and expansion of the benchmark definition such that it now includes oil from the Forties, Oseberg and Ekofisk fields, hence the acronym BFOE. Because the quality of oil from these different fields varies, the poorest quality oil sets the price for dated BFOE. Since 2007, this has usually been oil from the Buzzard field, which is part of the Forties. Dated BFOE refers to light, sweet crude oil from the aforementioned fields and, although it is often thought of as a spot market, it is an oil cargo with a specific loading slot for delivery in the next 10 to 25 days.

The dated BFOE price applicable in most long-term contracts is determined by a price reporting agency such as Platts, and is backed out from trades in the forward BFOE and contract-for-difference markets during a half-hour daily assessment window between 4:00 and 4:30pm London time2. Despite it being a very short window, most companies choose to transact during this time so as to influence the benchmark prices that may apply to their long-term contractual crude oil sales. In this way, the assessment window is not unlike a daily auction for forward, contract-for-difference and dated transactions, the end result of which is a dated BFOE price published at 4:30pm London time.

Because BFOE are waterborne crudes, the minimum trade size in the physical market is large at 100,000 barrels, or a partial cargo, which is approximately equal to three per cent of the average daily production for Norway and the UK4. Although the minimum shipment size acts as a prohibitive barrier to physical BFOE market entry, such that there are typically fewer than a dozen market participants at any given time, these participants are major global oil companies, and thus are some of the best informed, particularly on matters concerning supply (Fattouch, 2011).

http://www.ijmsbr.com
Futures contracts traded on ICE are linked to the physical crude oil markets by settlement against an index of forward prices. While dated BFOE is the key benchmark grade, the Brent futures contracts are vastly more liquid. Consequently, they may be the more important source of price discovery, especially outside the daily assessment window used by the price reporting agencies. In the front Brent futures contract there was an average of 75,790 trades per day from 2008 to 2011, inclusive. With an average trade size of 1.83 contracts and with each contract representing 1,000 barrels, average trade volume was equivalent to 138.7 million barrels per day over this period.

Fattouh (2011) postulates that ICE Brent futures drive forward BFOE prices through the exchange-for-physicals swap market. In turn, he suggests these markets influence, or are influenced by, dated BFOE prices through the contract-for-difference market according to transactions during the daily price assessment window of the major price reporting agencies.

C. West Texas Intermediate

While of a slightly higher quality than the BFOE grades, WTI is also a light, sweet crude oil which flows through pipelines from wells in Texas, New Mexico, Kansas, and Oklahoma to the storage facilities at Cushing, Oklahoma. The accessibility of physical WTI through pipelines allows smaller trades to occur than in the physical BFOE market, with a typical trade size of around 30,000 barrels (Fattouh, 2011). Consequently, there are fewer barriers to entry in the physical WTI market than the physical BFOE market and, thus, greater diversity of participants. However, in recent years trading in the Platts WTI Cash Window has virtually ceased and WTI “spot” prices are either prices posted by major oil companies such as ConocoPhillips (referred to as posting plus or P-Plus, which are wellhead prices plus delivery costs into Cushing) or are based on differentials to the Calendar Monthly Average market, which are largely driven by WTI futures anyway (see Fattouh, 2011).

WTI’s importance as a global benchmark arises from it being the main grade physically deliverable into the CME’s light sweet crude oil futures contract (the WTI futures). These contracts are often affected by expectations of storage and pipeline capacity constraints at Cushing, factors that have seen WTI less widely used as a benchmark and, historically, have reinforced WTI’s premium over Brent. Notwithstanding this, the recent expansion in shale oil production in North Dakota’s Bakken fields and oil sands production in Canada, both of which flow south to Cushing, have resulted in the opposite problem.

D. Price discovery

Crude oil derivatives may be more important to the price discovery process than the physical market (Schwarz & Szakmary, 2012; Silvapulle & Moosa, 1999; Fattouh, 2011).

III. TRADING TECHNIQUES

A. Pairs trading

Pairs trading is a technique developed in the 80s by a quant team of Morgan Stanley, the team was led by Nunzio Tartaglione and despite being initially extremely profitable, it disbanded with losses only a few years later.

It is essentially a statistical arbitrage technique used mainly by hedge funds, deployed on a massive scale as part of algorithmic trading systems. Furthermore this trading strategy can be considered as market neutral, as it’s independent of market movement. In fact traders who apply it can gain from upturns, downtrends, or sideways movements in the market.

The main idea behind this technique is to identify two financial instruments with similar historical price paths. Once this pair has been found, the undervalued security will be long and the overvalued one short, if at any point in time the distance between the relative prices (spread) exceeds the predetermined threshold. The two bets will generate profit as soon as the spread between the two financial instruments goes back to the historically observed level again in the near future. Basically, the bet that the spread will diverge only temporarily and it will eventually converge, always.

Nowadays research shows that 60% to 70% of stock trading volume is done by computers that operate HFT algorithms. There’s an argument that the increasing presence of High Frequency Traders provide liquidity to the market. Another view is that they distort the market acting as buyers and sellers of the same securities, adding fictional volatility to the process (Gatev et al., 2006). However, Do and Faff (2010) showed that smaller returns are not due to increased hedge fund activity as suggested by Gatev et al. (2006), but due to increased fundamental risk in the strategy as a larger number of pairs do not exhibit convergence that would enable profit making. This observation contradicts with Gatev et al. (2006), who concluded that the abnormal returns are compensation to arbitrageurs for enforcing the Law of One Price that assets with similar characteristics should have the same price. The finding of Do and Faff (2010) challenges the usefulness of pairs trading strategy created by Gatev et al. (2006). Results question the relevance of the Law of One Price acting as enforcer of the strategy. If a larger number of pairs do not converge, they can be assumed not to be similar in the context of the Law of One Price. That said, the economic reasons, if any, for the abnormal returns to the strategy remain uncovered.

Despite the documented declining profits, many papers have found pairs trading profitable under different settings in...
recent years. With a similar method to that of Gatev et al. (2006), Perlin (2009) found positive excess returns in the Brazilian stock market in years 2000-2006. As did Gatev et al. (2006), Perlin also exposed the market neutral strategy, suggesting that pairs trading could provide diversification benefits to an investor.

Mori and Ziobrowski (2011) reproduced the method used by Gatev et al. (2006) in a comparison between pairs trading with common listed stocks and listed Real Estate Investment Trusts (REITs). Studying the historical window 1987-2008, they found that REITs produced significantly larger abnormal returns over the period from 1993 to 2000. They proposed that the effect is due to the characteristics and regularization of REITs, because of which REITs are more homogeneous than stocks on average. Hence, better pairs with long-term relationships can be formed and the pairs are more appropriate for pairs trading. However, after the year 2000, REITs do not exhibit higher abnormal profits than common stocks. This could be explained by market recognition of the mispricing, according to Mori and Ziobrowski (2011). A similar argument about homogeneity can be used in utility stocks which produce most of the positive abnormal returns in Gatev et al. (2006) and Do and Faff (2010). Due to their generality, liquidity and simplicity, current researches are mostly focused on the stock markets. There are, however, some studies on pairs trading with other asset classes. Nath (2003) successfully tested the method by Gatev et al. (2006) for pairs trading with U.S., while Vayu Kishore (2012) found that statically estimating the parameters of the historical spread does not yield a strategy that is amenable to high-frequency trading, and using an allocation strategy advised by the theory of cointegration yields the poorest returns with the dynamically estimating spread.

B. High Frequency Trading

High frequency trading (HFT) is a phenomenon present in the financial markets since 1998, when SEC authorized electronic exchanges. It is an investment technique executed by powerful computers connected to fast networks that through the employment of program trading platforms transact large number of orders at ultra-rapid speed, applying complex algorithms to analyze multiple markets and carry out orders based on certain market conditions. Usually, the traders with the fastest execution speeds will be more profitable one, speed is a selective factor sometimes more important than the algorithm itself. As mentioned above, research shows that 60% to 70% of stock trading volume is done by computers that operate HFT algorithms. There is an argument that the increasing presence of High Frequency Traders provide liquidity to the market, another view is that they distort the market acting as buyer and seller of the same securities adding fictional volatility to the bourse.

IV. PROPOSED EMPIRICAL TESTING

This empirical test examines various risk factors in pairs trading of Brent crude oil first and second nearby future contracts, CO1 and CO2, under high frequency settings.

This research will show that the dynamic parameter estimation is more appropriate in a long-term investment; that faster trading generates higher abnormal return; that the optimal thresholds for opening and closing positions are set near the mean of the spread; that transaction cost is a strong risk factor of high-frequency pairs trading; and that pairs trading tends to be consistent under extreme event if the pairs are highly correlated.

In this empirical study, the answers to the following questions will be discovered:

a) Is the dynamic model more appropriate than the static model?

b) Do higher frequency data reduce the risk and enhance the return?

c) How does one select the optimal threshold line, width or value?

d) Do transaction cost ruin the whole strategy?

e) How effective is the model under extreme events?

V. CONCLUSION

Although HFT’s presence in crude oil futures markets has been on the rise, they are not significant in other commodity markets, due to its higher liquidity requirements. Some market participants argued that as more swaps activity shifts to electronic platforms, we should expect to see HFTs dominate in these markets.

However, HFTs’ survival depends on the short time delays in trade execution and on the initial liquidity in the market place.

REFERENCES


