

# Oxford Energy Comment

## March 2009

### Reinforcing Feedbacks, Time Spreads and Oil Prices

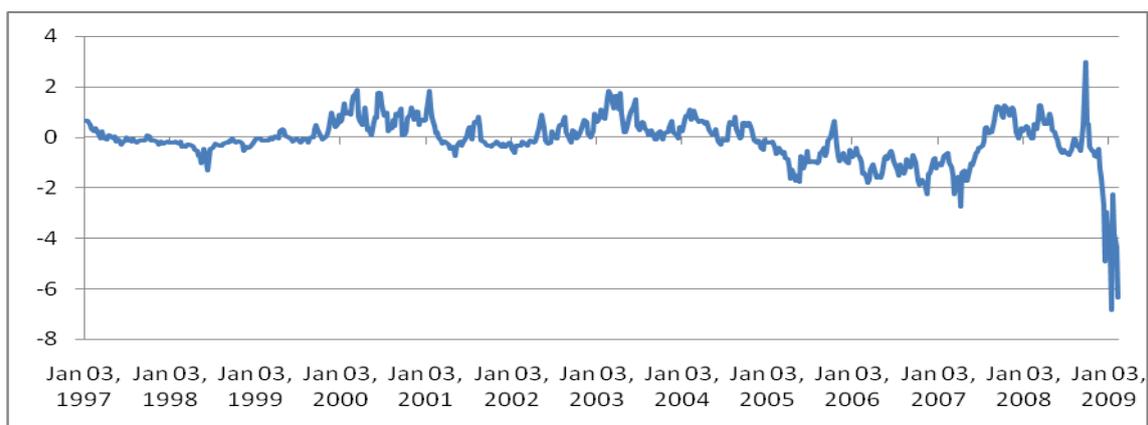
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By Bassam Fattouh<sup>1</sup>

#### 1. Introduction

One of the very interesting features in the recent behaviour of crude oil prices has been the increase in the variability of the spread between the oil futures prices at different maturities. Figure 1 below shows the weekly spread between the first-month and the second-month NYMEX Light Sweet Crude Oil futures contract (WTI contract) over the period 1997 to 2009 (13 February). The figure reveals the following three interesting features. The first one concerns the high volatility of the spread especially towards the end of our sample. During the period 1997-2009, the mean of the spread stood close to zero but with a relatively high standard deviation of \$0.92. The maximum and minimum values that the spread has taken range from -\$6.83 to +\$2.98 during this period. The second interesting feature is the frequent switches between backwardation and contango. While the crude oil market is expected to spend most of its time in backwardation, examining more recent data and focusing on the front part of the futures curve suggest the opposite. As can be seen from this figure, since 1997, the oil market has witnessed many switches from backwardation to contango. In fact, in our sample the first-month futures crude oil prices were below the second-month prices more than 55% of the time. In other words, the crude oil market has been in partial contango for longer than it has been in backwardation. The third observation concerns the persistence of backwardation or contango regimes. In April 1997, the oil market entered into a contango which lasted until August, 1999. In May 2002, the market entered into a long backwardation which lasted until mid 2003. In November 2004, the market entered into prolonged contango which lasted until mid 2007. In October 2008, the market switched to a contango which many observers expect to last for a long time.

**Figure 1: First-Month WTI Contract minus Second-Month WTI Contract**



Source: Energy Information Administration (EIA) website

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The large variability of the spread, the occasional switches from backwardation to contango, and the persistence of the regimes raise a series of questions: what can explain the dynamic behaviour of the spread in recent years? Is the behaviour of the spread really unusual? This article tries to provide some answers to the above questions by drawing some lessons from the period 1997-2009. But before discussing these issues in detail, it is worth describing very briefly how economists explain the variability of the spread and highlight some of the limitations when these theories are applied to the oil market.

## 2. What does theory tell us?

One way to explain the variation in the basis is in terms of a risk premium which arises in the process of transferring risk from hedgers to speculators. Specifically, the basis can be written as the sum of the following two main components: the expected change in the spot price and the ex-ante risk premium. The risk premium can be positive or negative (and hence the basis can take negative or positive values) depending on investors' beliefs, endowments, and preferences.<sup>2</sup>

An alternative theory, the theory of storage, explains the difference between the futures price and the spot price of a commodity in terms of interest foregone in purchasing and storing the commodity, storage costs, and the convenience yield. The latter is defined as a yield or benefit that "accrues to an owner of physical asset but not to an owner of a contract for future delivery of the commodity".<sup>3</sup> The convenience yield affects the basis through arbitrage. When the convenience yield goes up, the attractiveness of holding futures contracts relative to physical stocks goes down. This will lower the futures price and increase the spot price until the futures price is equal to the spot price plus the cost of carrying the commodity (cost of storage and the interest cost).

Studies based on the storage model relate the convenience yield directly to the level of inventories. Generally, the theory of storage suggests that marginal convenience yield falls with inventory but at a decreasing rate. At low levels of inventory, the marginal convenience yield is larger than carrying costs and the spot-futures price spread is positive. As the level of inventories goes up, the marginal convenience yield falls towards zero and the spot-futures price spread becomes negative and converges towards the cost-of-carrying the commodity. More recent models describe the convenience yield as a financial call option held by storage agents. The call option can have value when, for example, demand shocks create a positive probability that agents can sell their stocks at higher price during the storage period.

## 3. What is missing in these models?

While these models are very useful in explaining the behaviour of time spreads,<sup>4</sup> there are three features that one should consider in the context of the crude oil market. The first is related to the feedback mechanism and the possibility that the market can enter into reinforcing feedbacks. The second feature is related to the oil market structure where OPEC can play the role of an active or a passive quantity adjuster which can affect the process of inventory accumulation and the behaviour of the spread. The third feature is related to the fact that reinforcing mechanisms can lead to the dislocation of key benchmarks used for oil pricing with wide implications on the behaviour of key spreads such as the WTI-Brent spread, time spreads and heavy-light price differentials.

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<sup>2</sup> Bailey, W. and K. C. Chan (1993). Macroeconomic Influences and the Variability of the Commodity Futures Basis, *Journal of Finance*, 48(2): 555-73.

<sup>3</sup> Brennan, M. J., and E. S. Schwartz (1985). "Evaluating Natural Resource Investments," *Journal of Business* 58, 2: 135-157.

<sup>4</sup> For details, see Bassam Fattouh (2009), "Basis Variation and the Role of Inventories: Evidence from the Crude Oil Market", Oxford Institute for Energy Studies WPM 38.

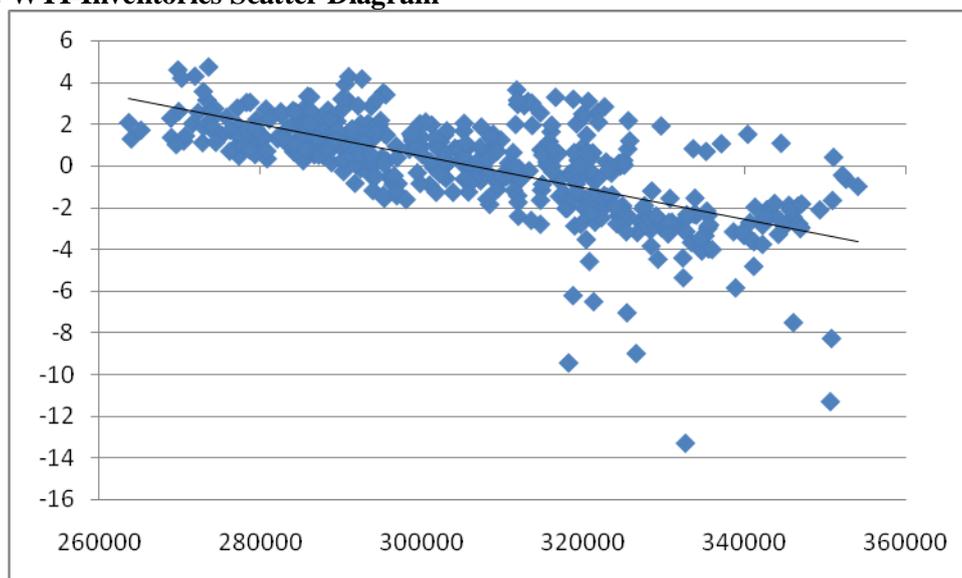
### **Reinforcing Dynamics**

While most empirical studies focus on how changes in inventories affect the variability of the spread, the feedback mechanism from the spread to inventories is rarely explored. These feedbacks are important as they often result in reinforcing dynamics which may take a long time to break. Specifically, increases in the level of inventories would push prices for immediate delivery down as a higher level of inventories is often interpreted as a sign of a well-supplied market. At the same time, the convenience yield of holding inventories goes down pushing the futures price upward. The end effect is a widening spread between the price for immediate delivery and price for future delivery. This in turn will induce further accumulation of inventories as traders take advantage of widening spreads. This process can continue for a long time and can be broken in either two ways. At a sufficiently high level of inventories, the marginal storage becomes increasingly expensive. Alternatively, oil producers can decide to cut supplies and prevent physical traders from accumulating inventories.

In 1998, the oil market was trapped in such a reinforcing mechanism. A decline in oil demand due to the Asian financial crisis and a market perception that OPEC supplies had increased resulted in a sharp fall in prompt prices relative to oil prices for future delivery. This triggered the accumulation of crude oil which led to a decline in spot prices and a widened contango. This reinforcing contango was broken after a series of output cuts which saw OPEC withdraw more than 1 billion barrels from 1999 to early 2000.

While a reinforcing contango is usually associated with sharp declines in oil prices, this is not always the case. In 2006, the reinforcing contango and the associated rise in inventories went hand in hand with rising oil prices. This is because the spread and not the price level drive the dynamics. As long as futures prices are rising faster than prompt prices, these reinforcing mechanisms are likely to prevail. Thus, in the last few years while the inverse relationship between inventories and prices seems to have been broken on some occasions, the relationship between inventories and the spread did not change as can be seen from Figure 2 which plots a scatter diagram of the WTI spread (measured as the difference between the first and fourth month contract) and the level of inventories.

**Figure 2: WTI-Inventories Scatter Diagram**



These dynamics can also work in the opposite direction as occurred in the first half of 2008. Despite evidence of weaker oil demand growth, declining inventories continued to push up spot prices (falling

inventories are seen as indicating a supply shortage). Now let's suppose that refineries thought at that time that the rise in the oil price was only temporary and that weaker oil demand would eventually bring prices down. This would induce them to use their own stocks. Thus, although oil demand growth was slowing down, spot prices kept rising as traders were coordinating on public signals about declining inventories. This deepened and prolonged the backwardation and decreased the incentive to hold stocks as it was not profitable to do so. This process can continue until stocks reach minimum operating levels or until there is a change in market sentiment as happened in the second half of 2008.

This leads us to the analysis of the recent behaviour of the spread. As can be seen from Figure 1, the market has entered into a contango which many market participants expect to be prolonged. Fears about the impact of the deteriorating prospects of the global economy on oil demand have been placing a downward pressure on front month oil prices. While both the front end and the back end of the oil price curve have seen sharp declines in the past few months, long-term oil prices have fallen more slowly. This term structure is providing incentive for traders to accumulate inventories. Higher levels of inventories are in turn leading to further falls in oil prices which is keeping the contango wide. If weaknesses in oil demand from US refineries persist, then it may take a long time for these reinforcing dynamics to reverse and the downward pressure on the WTI could continue for some time.

### **The Role of OPEC**

Unlike other markets, OPEC can affect the rate of accumulation of inventories either through an active or passive policy. In terms of active policy, OPEC can decide to target the level of inventories. Specifically, high levels of stocks may increase the incentive for OPEC to engage in output cuts if the Organization feels that high stock levels can induce a sharp downturn in oil prices.<sup>5</sup> OPEC cuts would have the effect of lowering inventories and raising the price at the front end of the futures curve increasing the probability of the basis moving back into backwardation. The speed at which OPEC can achieve this depends on the tightness of market conditions and how effective OPEC is in implementing these cuts. This could explain the switches in 1997 and 2006 from contango to backwardation. In terms of passive policy, OPEC can continue to supply upon demand based at prevailing market prices. This helps balance the market without an increase in inventories. These dynamics were present in the first half of 2008. Despite the fall in demand, excess supply did not appear in the market and we did not witness any significant rise in inventories as OPEC passively adjusted its output to counteract the decline in oil demand.

### **The Breakdown of the Benchmark**

The third distinguishing feature of the oil market is that these reinforcing mechanisms affect the behaviour of a key benchmark with very wide implications on oil prices. Since the adoption of formula pricing in 1986, WTI has served as one of the main international benchmarks, along with Brent and Dubai, against which other types of crude oil are priced. Thus, reinforcing dynamics affect the entire pricing mechanism and arbitrage between markets. Furthermore, the time spread affects the attractiveness of oil as a financial asset by affecting the roll return on passive futures based commodity investment i.e. the return from selling the expiring contract and buying the new front month contract (in a contango the roll return is negative).

It has long been recognized that the links between the WTI benchmark and oil prices in international markets can be dictated by infrastructure logistics. In 2007, due to logistical bottlenecks which resulted in a large build-up of inventories at Cushing, Oklahoma the WTI disconnected not only from the rest of the world, but also from other US regions. In the current market conditions, something similar is taking place though the cause for the build-up of inventories is different. Due to a

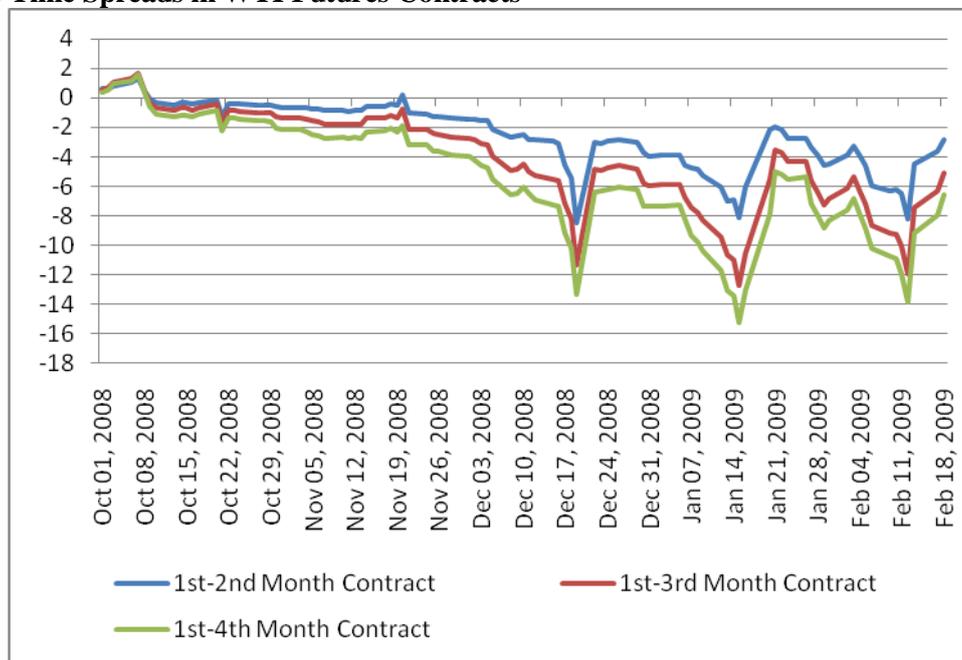
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<sup>5</sup> See Bassam Fattouh (2009), "Basis Variation and the Role of Inventories: Evidence from the Crude Oil Market", Oxford Institute for Energy Studies WPM 38.

reinforcing contango, Cushing is being flooded with inventories. Crude inventories at Cushing have grown from 14.383 million barrels in October 2008 to almost 35 million barrels by the second week of February, an increase of almost 20 million barrels. This increase in crude oil inventories is concentrated in Cushing and not in the rest of the US because traders can implement the arbitrage most effectively at Cushing, which is the delivery point for the futures contract.

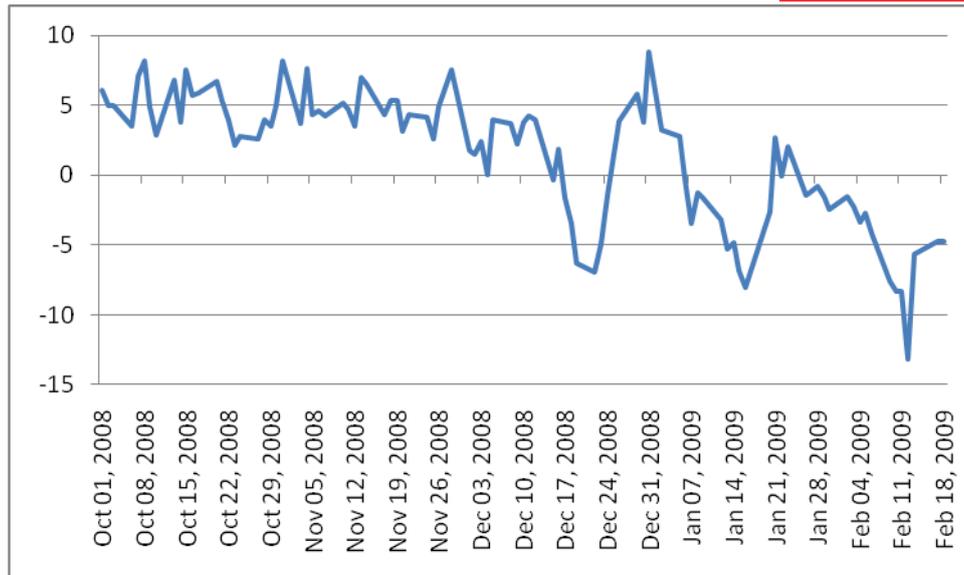
The effects of this rapid build-up of inventories in Cushing, are widespread and affected the oil price structure in three major ways. First, the feedback is creating distorted sets of time spreads as reflected in the large differential between nearby contracts and further away contracts with the spread between first month-second month reaching more than \$8 per barrel and much higher for spreads between first month and further away maturities (see Figure 3).

**Figure 3: Time Spreads in WTI Futures Contracts**



Second, the WTI decoupled from Brent, as reflected in the large differential between the prices of the two international benchmarks. As can be seen from figure 4, the differential has exhibited high volatility in recent months and although WTI and Brent are of similar quality (light and sweet), WTI has recently been trading at large discounts to Brent.

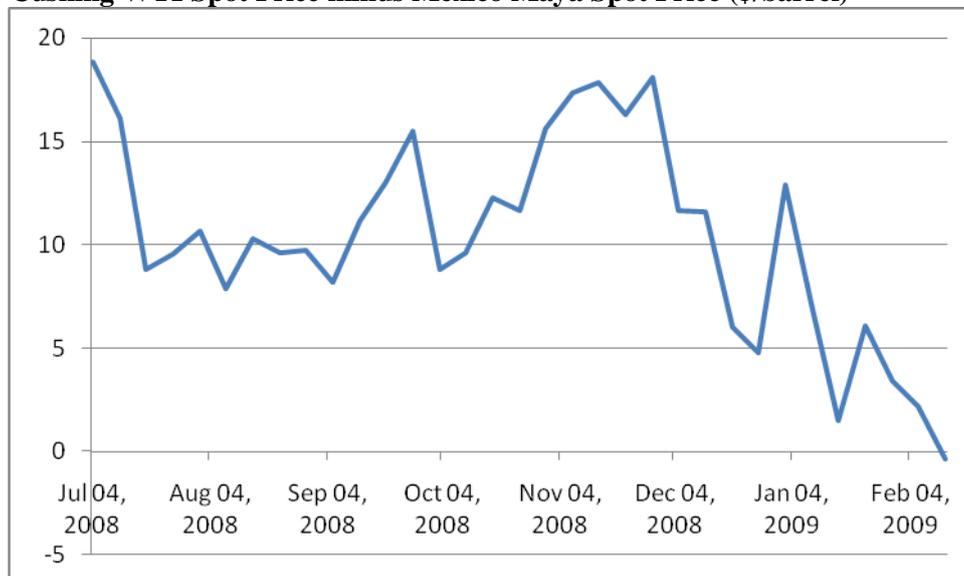
**Figure 4: Cushing WTI Spot Price minus European Brent Spot Price (\$/barrel)**



Source: EIA

Third, the build-up of stockpiles around the area of Cushing has also resulted in the sour-sweet crude oil price differential narrowing to very low levels. Figure 3 below shows that while WTI was trading at a premium of more than \$20 to Mexican Maya Blend in the middle of 2008, the differential has narrowed considerably and On February 13, 2009 Mexican Maya was trading at a small premium to WTI. This can also be explained by the fact that most OPEC production cuts are usually concentrated on heavy crudes thus strengthening heavy crude prices.

**Figure 5: Cushing WTI Spot Price minus Mexico Maya Spot Price (\$/barrel)**



Source: EIA

In short, WTI's dislocation has had serious implications across the various crude oil markets, resulting in unusual price differentials. These effects, however, do not imply that the market is not functioning well. On the contrary, price movements are efficiently reflecting the local supply-demand conditions in Cushing. The main problem is that when localized conditions become dominant, the WTI price can no longer reflect the supply-demand balance in the US, nor act as a useful international benchmark for pricing crude oil.

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#### **4. Conclusions**

While the media often focuses on the sharp swings in the oil price, there have been some interesting feedbacks unfolding in the term structure of oil prices with wide consequences on the international pricing system, financial investment, inventories and OPEC behaviour. These feedbacks are not new to the oil market, but the current environment seems to have amplified these price distortions. While the market will eventually succeed in eliminating these price distortions and market dislocation, the fact remains that these reinforcing feedbacks seem to have become more common in recent times and take longer to break. While one might think that these recurring events will push market players to look for an alternative benchmark, history has shown that the market can tolerate such anomalies. This suggests that market players need to get prepared for some more sharp irregularities in prices and spreads in months to come.