

# The Importance of the Structural Shape of Crude Oil Futures Curves

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## **Structural Shape of Crude Oil Futures Curves**

In the past, one could confidently discuss how crude oil futures contracts typically trade in "backwardation." By backwardation, one means that a near-month futures contract trades at a premium to deferred-delivery futures contracts. For example, Litzenberger and Rabinowitz (1995) pointed out that the NYMEX West Texas Intermediate (WTI) crude oil futures contract's front-to-back futures spreads were backwardated at least 70% of the time between February 1984 and April 1992. This pattern was so persistent that these authors theorised why this should be the typical shape of the crude oil futures price curve.

This structural feature of the crude oil futures market persisted for another 11 years. Goldman Sachs (2003) reported that from March 1983 through February 2003, the WTI futures contract had "been in backwardation 62% of the time[,] delivering an average yield of 0.78% per month." Because of the persistence of backwardation in the crude oil futures market, practitioners could come up with the concept of a positive "roll yield," which is earned from continuously buying and rolling crude oil futures contracts. The idea is that even if the front-month price of a crude oil futures contract is stable, there can be a positive return since one is continuously buying deferred futures contracts at a discount to where they eventually converge to, resulting in an accumulating "roll yield" over time.

## **Roll Yields in Performance Attribution**

Further, Anson (1998) shows that from 1985 through 1997, roll yields accounted for essentially all of the futures-only returns in an investment indexed to the petroleum-complex-heavy (S&P) Goldman Sachs Commodity Index.

Anson's article showed how the total returns of a collateralised commodity futures program can be ascribed to (1) spot return; (2) roll yield; and (3) the T-Bill return. The spot return and the roll yield account for the "futures only" return of the program. Once one includes the T-Bill return from fully collateralising the program, one arrives at the total return of such a program. We should emphasise that both the spot return and the roll yield are artefacts of this particular method of performance attribution. In a futures program, one cannot directly receive the spot return separate from the roll yield; and correspondingly, one cannot directly receive the roll yield separate from the spot return. Again, though, the advantage of this type of performance attribution is it makes clear that buying and rolling a structurally backwardated commodity futures contract can have positive returns, even when its spot price is stable (or mean-reverts.)

## **Rolling a Futures Contract Does Not Actually Generate Returns**

Now, both practitioners and academics have recently pointed out that one needs to be very careful in defining commodity futures "roll yields." The act of rolling from one contract to the next does not in itself generate returns, just as selling Ford stock to buy GM stock does not in itself generate returns, as explained by Sanders and Irwin (2012). Instead, roll yields are an artifact of one type of performance attribution, as discussed above.

## **But the Commodity Futures Curve's Structural Shape Can Be Predictive of Futures Returns**

That said, there is comfort in the peer-reviewed literature with treating a commodity futures contract's curve shape as predictive of future returns. For example, amongst the research covering this topic, Gorton, Hayashi, and Rouwenhorst (2013) examine 31 commodity futures over the 1971 to 2010 period. They find that "a portfolio that selects commodities with a relatively high basis ... significantly outperforms a portfolio with a low basis ..." The authors define "basis" as

"the difference between the current spot price and the contemporaneous futures price." In other words, the winning portfolios contain futures contracts that are relatively more backwardated than the losing portfolios. The authors provide a fundamental rationale for their results, linking relatively high-basis futures contracts with relatively low inventories (and correspondingly, relatively more scarcity.)

## 2004's Structural Break in the Oil Futures Markets

Prior to 2004, if there were scarcity in the crude-oil market, one could expect two outcomes: (1) increasing spot prices; and (2) for the front-month price to trade at an ever larger premium to deferred-delivery contracts. Reflecting this relationship, there had been a +52% correlation between the level of outright crude prices and the level of front-to-back-month calendar spreads from December 1986 through December 2003.

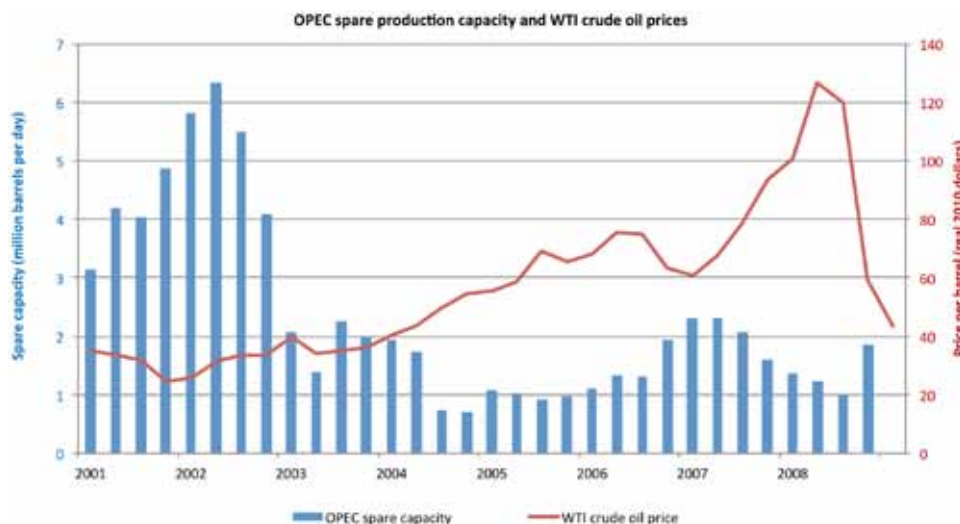
As discussed at the outset of this article, when the front-month price trades at a premium to the deferred-delivery contracts, this is known as backwardation. When a futures curve instead trades in contango, the front-month price trades at a discount to the deferred-delivery contract. In times of surplus, inventory holders receive a return-to-storage, as represented by the size of the contango, since they can buy the crude oil immediately at a lower price and lock in positive returns to storage by simultaneously selling the higher-priced contract for a future delivery. If inventories breach primary storage capacity, the crude curve will trade in deeper contango, so as to provide a return for placing the commodity in more expensive, secondary storage (and eventually, tertiary storage.)

The WTI crude curve's structural relationship changed from 2004 to the summer of 2007. During that time period, the level of crude-oil prices became -75% correlated with its corresponding calendar spread.

Through the summer of 2007, the structural rigidities in the crude oil market translated into large contangos and high flat prices. What changed during 2004? Please see Figure 1. During mid-2004, OPEC's immediately-deliverable spare capacity collapsed. The International Monetary Fund later explained in IMF (2005) that this occurred because of "[s]ynchronized global growth, high oil demand (especially from China), and a series of supply disruptions ..."

## Why does this matter?

Figure 1



Graph is excerpted from EIA (2014), Slide 12.

U.S. Energy Information Administration (EIA): "The extent to which OPEC member countries utilize their available production capacity is often used as an indicator of the tightness of global oil markets ... EIA defines spare capacity as the volume of production that can be brought on within 30 days and sustained for at least 90 days. ... OPEC spare capacity provides an indicator of the world oil market's ability to respond to potential crises that reduce oil supplies."

As explained in Harrington (2005), the true inventories for crude oil should be represented as above-ground stocks plus excess capacity. Historically, the markets had been able to tolerate relatively low oil inventories because there was sufficient swing capacity that could be brought on stream relatively quickly in the case of any supply disruption.

In contrast, during 2004, the oil market's excess supply cushion dropped to sufficiently low levels that there were two resulting market responses: (1) there were continuously high spot prices to encourage consumer conservation, and (2) the market undertook precautionary stock building, which arguably led to the persistent (but not continuous) contangos that the crude oil market began experiencing in late 2004.

By July 2008 the excess-capacity cushion became exceptionally small relative to the risk of supply disruptions due to naturally-occurring weather events as well as due to well-telegraphed-and-perhaps-well-rehearsed geopolitical confrontations. At that point, the role of the spot price of oil was arguably to find a level that would bring about sufficient demand destruction to increase spare capacity, which did occur quite dramatically, starting in the summer of 2008, after which the spot price of oil spectacularly dropped by about \$100 per barrel by the end of 2008.

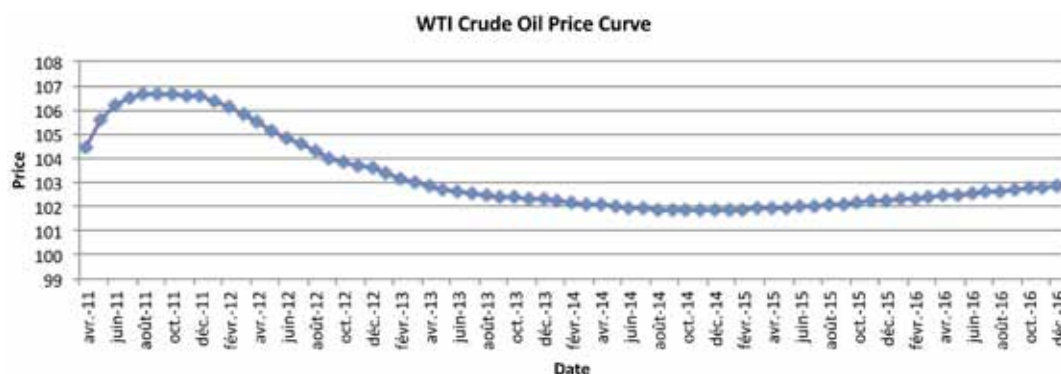
### Possible Return in Importance of Roll Yields

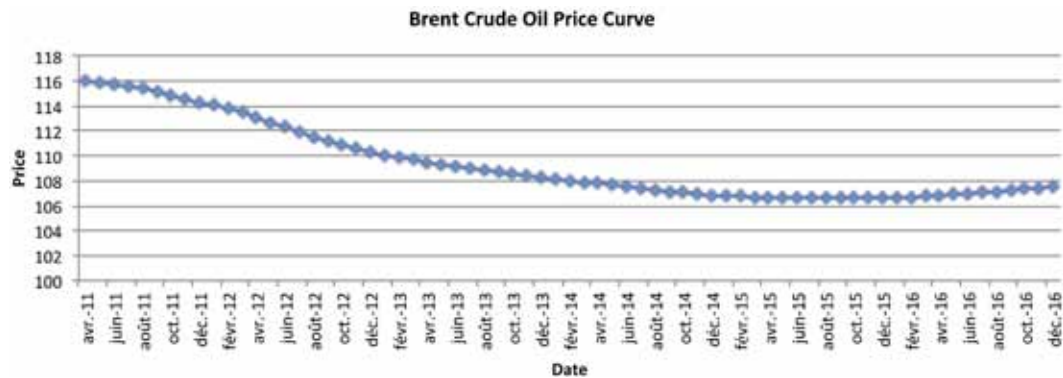
Could we be in a state-of-the-world where fears on worryingly low OPEC spare capacity are diminishing? There is definitely not universal agreement on this topic, but at least according to the International Energy Agency (IEA), "OPEC's spare crude oil production capacity will surge 25 percent in the next two years as rising U.S. shale output crimps demand for the group's supplies," reported Nguyen (2013) in *Bloomberg News*.

If OPEC spare capacity were not in question, then there would not be a need for precautionary stock building, which would mean that relatively low oil inventories would be tolerable. And typically when there have been low crude oil inventories, the oil futures curve has been backwardated, leading to positive "roll yields."

The above analysis applies to any oil futures contract that is seamlessly connected to the global oil markets. This is because we are using a measure of global oil market tightness, OPEC spare capacity, as a plausible explanatory variable for whether one can expect positive roll yields. As noted in Blas (2011) in a *Financial Times* article, "From time to time, the [WTI] contract [has] disconnect[ed] from the global oil market due to logistical troubles at its landlocked point of delivery in Cushing, Oklahoma." The result has been a different curve shape and different returns from buying and holding Brent crude futures contracts versus WTI crude futures contracts. For example, please see Figure 2.

Figure 1





Source of Data: The Bloomberg. Futures Curves as of March 4, 2011.

Bloomberg Tickers for Return Calculations -- WTI: SPGCCLP and Brent: SPGCBRP.]

That said, Platts (2013) has noted that "many pieces of the logistical puzzle" in North America are now falling into place, due to the "ingenuity of logistical engineers," in managing the increase in U.S. domestic crude supplies. Further, in JP Morgan (2013), the bank's commodity analysts have written that "the boom in ... [domestic oil] production has been well absorbed by existing U.S. infrastructure ... [T]ruck, rail, and barge have all served to move the large increase in domestic crude supplies to U.S. refineries," whom, in turn, can export petroleum products abroad. This has been the mechanism for connecting the U.S. oil markets to global markets since exporting crude oil itself is presently illegal with some minor exceptions. To the extent that this logistical ingenuity continues, one could be justified in seeing a return in the importance of roll yields as an ongoing driver of returns for holding WTI oil futures contracts, just as has been the case for Brent oil futures contracts. Both the WTI and Brent oil curves are currently trading in backwardation.

### Going Forward: Backwardation, Swing Capacity, and Roll Yield

It may be that a whole host of systematic futures strategies and indexes that exploit structural backwardation in the crude oil futures markets might properly become in vogue again. For example, JP Morgan (2013) noted that amongst 65 commodity index products, two of the indexes, which emphasise backwardation, may have excellent prospects over the next two years.

Further, PIMCO's commodity portfolio managers noted in Johnson and Sharenow (2013) that "as long as Saudi Arabia maintains the ability to manage imbalances in the market and shale extraction prospects remain good, we expect the oil market roll yield to look similar to that in the 1990s ..."

In conclusion, we may be returning to a Litzenberger-and-Rabinowitz state-of-the-world of structurally backwardated oil futures curves. In that case, it may be useful to revisit research done in the 1990s on structural drivers of both oil-futures and commodity-index returns.

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