



## What Can the Commodity Market Tell Us About Peak Oil?

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*This is a guest post by [Shunyata](#). Shunyata is a manager of financial derivatives with training in financial engineering, actuarial science, statistics, and mechanical engineering. While he does not work directly with commodity markets, his background in financial engineering gives him insight into the operation of oil markets that may be helpful.*

The observations below represents Shunyata's opinions based on his study of commodity derivatives to protect his personal interests. Commodity derivatives are exceedingly complicated, and his direct expertise is with respect to financial derivatives. This post is not intended to represent investment advice.

### What Can the Commodity Market Tell Us about Peak Oil?

#### Market Consensus

A common view is that market prices reflect the market consensus about future prospects. This is a dangerous misunderstanding from several standpoints.

Consensus is an equilibrium statement, but *equilibrium is non-existent in reality*. There is the obvious problem of new information constantly disrupting the market. More importantly, the market contains a hidden, complex structure of players:

- There are large, in-the-know entities who act opportunistically, seemingly at random;
- There are hedgers who react to market moves mechanically and in unison (no disparagement intended);
- There are diverse small players who respond slowly in diverse ways, etc.

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The existence of discrete blocks of players who act in different trading volumes executed over different time scales guarantees that prices will deviate significantly from fundamentals and suffer unexpected corrections. From a theoretical standpoint, you can find these ideas in Sornette, [Why Markets Crash: Critical Events in Complex Financial Systems](#). From an eminently pragmatic standpoint you can find these ideas in Taleb, [Dynamic Hedging: Managing Vanilla and Exotic Options](#).

Even in equilibrium market consensus does not hold for derivatives.

## **Futures Contracts - Introduction**

A common derivative is the futures contract where, loosely speaking, we agree that at a specified future date you will give me one unit of something (a unit of the S&P500, a barrel of oil, etc.) at the 'future' price we set today. Because this agreement deals with a specific date, we talk of a 'futures curve' that shows the exchange price people are agreeing to for exchanges occurring today (this is also called the spot price), one or three months from now (this is also called the front contract), six months from now, etc.

And, being standardized contracts, futures are typically defined only out to five or ten years. (Savvy readers will note there is a bit of hand-waving here but the intuition reasonable. For a more complete discussion of commodity futures contracts and quoting conventions see Geman, [Commodities and Commodity Derivatives](#)).

### **Replication Cost as a Driver of Futures Costs**

Stepping away from the complexity of commodities for a minute, consider the agreement to exchange one unit of the S&P500 on a specific day three months from now at a specified 'futures' price. Interestingly, the price of this transaction has virtually nothing to do with the consensus expectation of S&P500 levels three-months from now! Why? I can borrow money, buy the item today, hand it over tomorrow, and use the money you give me to pay off my loan. I just need to make sure the future price we agree to pays off my loan. Then the whole thing is a zero-sum game. (Clearly this is theory. In reality the smaller fish lose a little bit every time.)

This mechanic is called market replication and replication cost is a pivotal driver in any future or derivative price. (See Baxter and Rennie, [Financial Calculus: An Introduction to Derivative Pricing](#) for an approachable introduction to the theory of replication. But be forewarned that there is a lot of artistic praxis involved as well.)

If we think through this mechanic, we can see that futures should be more expensive than the current spot price because that loan has to be paid back with interest. In fact, you can see this lock-step replication cost linkage between today's S&P500 level and the price of S&P500 futures.

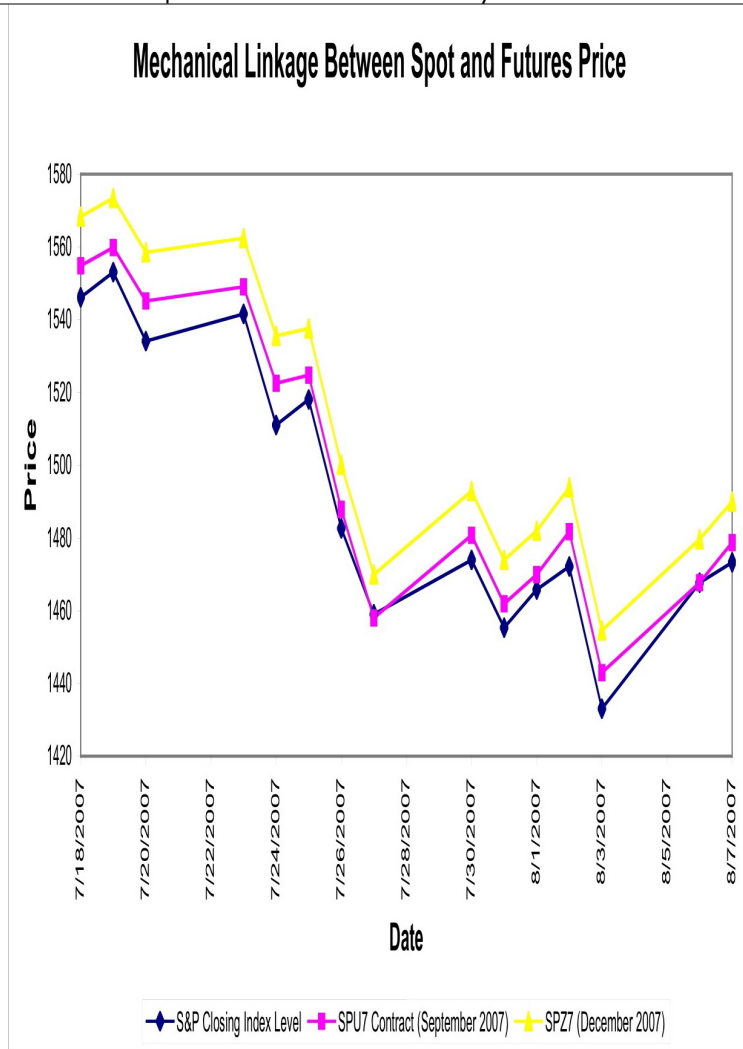


Figure 1: Mechanical Link Between Spot and Futures Price for S&P 500

In short, the ability to replicate derivatives (the work of so-called Wall Street Rocket Scientists) guarantees that all prices are self-consistent, and perhaps all equally delusional. Put another way, replication works to keep RELATIVE prices all self-consistent, but the ABSOLUTE LEVEL of prices is completely driven by fear/greed, supply/demand, etc. It isn't anchored by anything except willingness or unwillingness to speculate. Couple that with the market structure issues noted above and any notion of consensus is out the window.

### Difference Between Commodity Futures and Financial Futures

As if all of this weren't complicated enough, commodities such as oil are significantly different from securities like stock shares, and it is very important to remember this.

Commodities are consumables; new units of commodities are produced, delivered to the marketplace for exchange, and then destroyed (hopefully to produce something of value). This creates an entirely different dynamic than a stock market where the same pot of IBM shares is effectively around today and five years from now. A commodity futures contract is an agreement involving a unit that may not even exist today!

### Consensus Oil Price

It is important to understand that nationalized corporations and government entities control

much of the world's oil production (think Aramco, Pemex, etc.) and consumption (think the Air Force, strategic petroleum reserve, etc.). This means that there can be sudden and profound upsets to the production/consumption flow of the dynamic pot of commodity units.

As such it seems that oil futures might be more linked to consensus - but consensus about what? There are three elements here:

- Cost to produce,
- Ability to deliver, and
- Demand for the product.

Who exactly is controlling the production/consumption flow? And who, therefore, is controlling the price?

1. Historically, the cost to 'stick a straw in the ground' has been quite low so oil prices have been quite low. However, as more straws are required, are harder to stick in, or harder to locate, we should expect futures prices to rise.

2. Commodities are exchanged at specific physical locations. Bottlenecks getting material into and/or out of these specific locations can cause counter-intuitive price dislocations for contracts specifying exchange at these locations. (This is why we talk about Brent Crude, WTI Crude, etc. And obviously physical bottlenecks aren't a problem for an electronically designated share of IBM stock.)

These distribution bottlenecks are part of the reason why Cushing (Oklahoma) oil has historically traded at a premium to Brent (UK). Infrastructure restrictions made it difficult to move desired quantities through the system so that local buyers were forced to pay a premium to obtain the available supply. For a discussion of this see this [article](#).

3. Finally, if substitutes are available, significant price increases can create permanent alterations in demand. This will tend to hold futures prices lower.

Replication cost is also a consideration, but historically it has been much more expensive to purchase oil today, store it securely, and deliver it at the settlement date compared to producing it and directly delivering. When replication isn't practically feasible, then consensus has the ability to drive price. We just need to figure out whether production, distribution, or consumption is in control. (In the future, however, if lower levels of production are more proportionate to storage capacity and cost, replication cost may become more important and moderate the impact of consensus.)

### **How Do Oil Futures Actually Behave?**

So how do futures prices actually behave in the market? Can we tell who is driving the price and what does this tell us about our spot on the Peak Oil timeline? Of course no one really knows and the trinity of supply, delivery, and demand makes it difficult to decipher what is driving futures prices. Furthermore, our ability to construct a posteriori explanations is limitless, rather like seeing animals, faces, etc. in cloud patterns. Nonetheless, let's see what we can divine.

Oil futures prices are usually LOWER than today's purchase price. Sellers usually agree to sell their oil tomorrow for less than it is selling today. This situation is called 'backwardation' of futures prices. This pattern is shown in Figure 2 below. Prices tend to decline between early

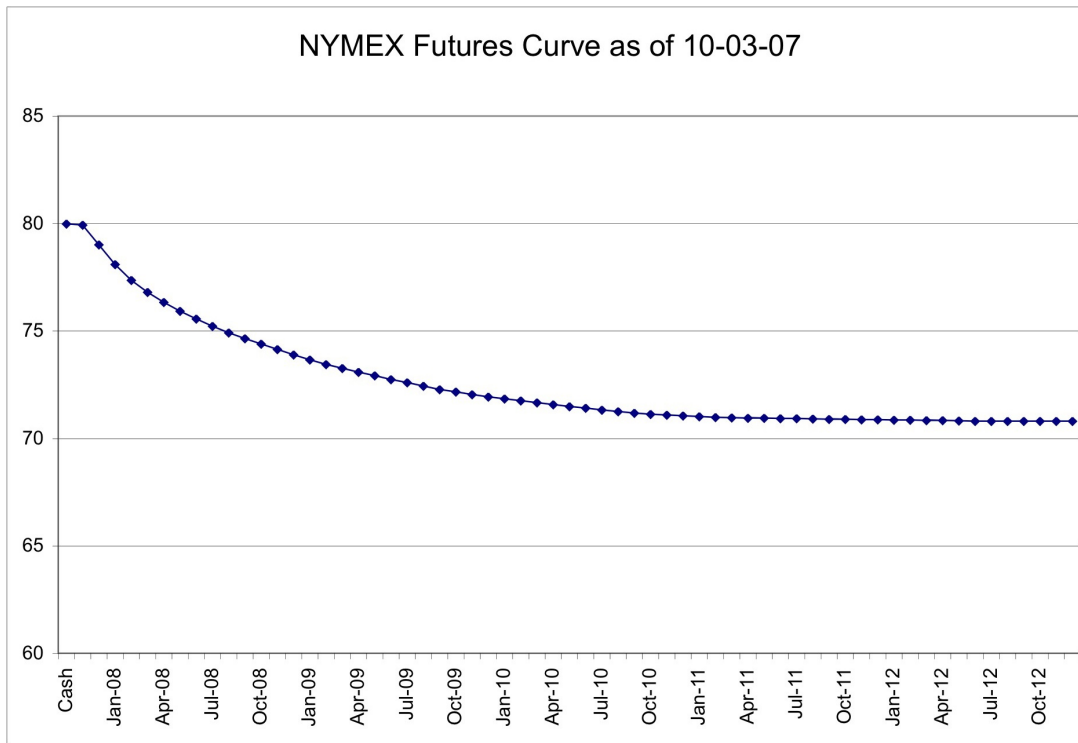
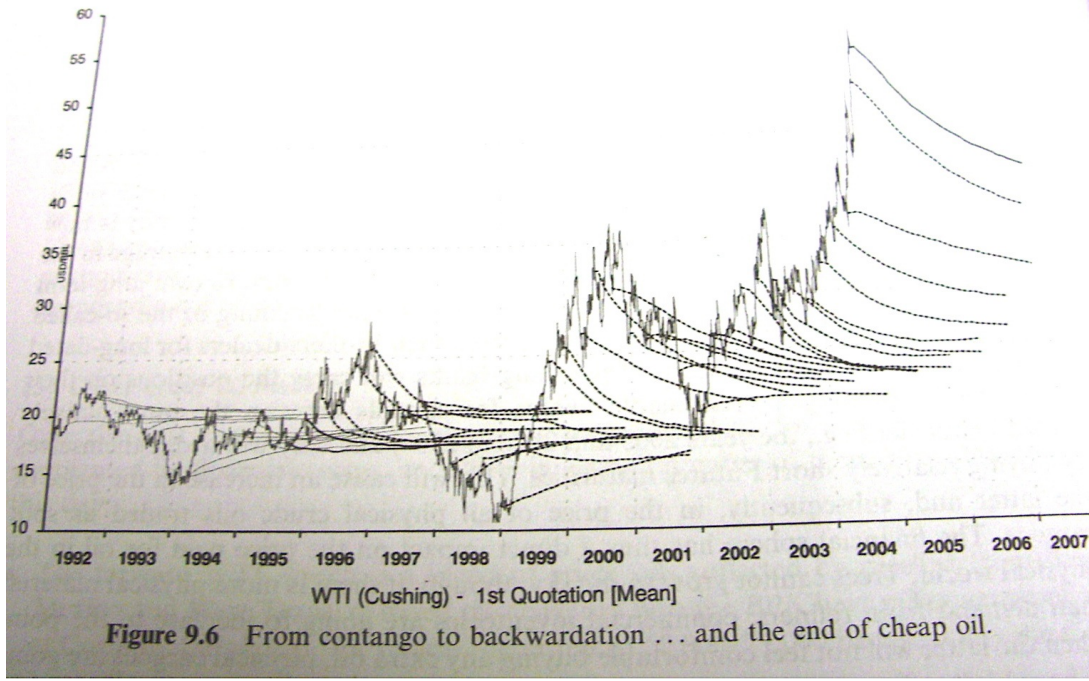


Figure 2: West Texas Intermediate Oil Futures Curve as of August 31, 2007

So why should future production generally trade at a discount to today's oil? Doesn't this imply that oil will be MORE plentiful in the future? The most common speculation is that the futures market is driven by producers who are willing to pay an 'insurance premium' to guarantee future revenue. Presumably producers have been worried about prices dropping below current levels, or even below their production costs, and have been eager to "pre-sell" at acceptable prices negotiated today.

And there is some historical evidence that this view has historically controlled prices. If prices drop sufficiently below production costs, then buying oil and delivering later is feasible, replication should dominate prices, and futures should trade at a premium to current price. This is exactly what we see historically. Upward sloping futures curves only occur at the deepest dips in oil prices. This is illustrated from in Figure 9.6 from Geman, [Commodities and Commodity Derivatives](#).



Interestingly, the market level at which dips trigger upward sloping yields curves has risen over time. It would be interesting to know what linkage there is between these increasing levels and increasing production cost. Perhaps some readers have this information at their disposal?

### Oil Futures Prices Under Peak Oil

Under peak oil, we would expect to see more upward sloping futures prices (sometimes called contango), even when there are not price dips.

Under peak oil, the market will probably be driven by the demand side so that prices will tend to stay far above production costs (unless governments begin interfering too heavily, insisting upon affordability and protecting economic growth). And consequently discounted futures prices (backwardation) suggest that the producers are in control and all is well with the world... unless production costs are rising faster than the overall price of oil. Then producers would still seek "insurance" even as oil costs went through the roof and we should be worried indeed.

On the other hand, upward sloping futures curves (contango) clearly indicate that the producers are out of control -- the condition we would expect to see with Peak Oil. In 2004/2005 the futures curve became very steeply backwardated implying that market that producers were willing to pay a large premium to lock in pricing. Subsequently, however, the curve has flattened out dramatically even as we reach new spot price highs. Since production costs haven't been coming down and market volatility hasn't been coming down (so that producers are no longer concerned about buying insurance), we have a strong indication that demand is beginning to rule the roost.

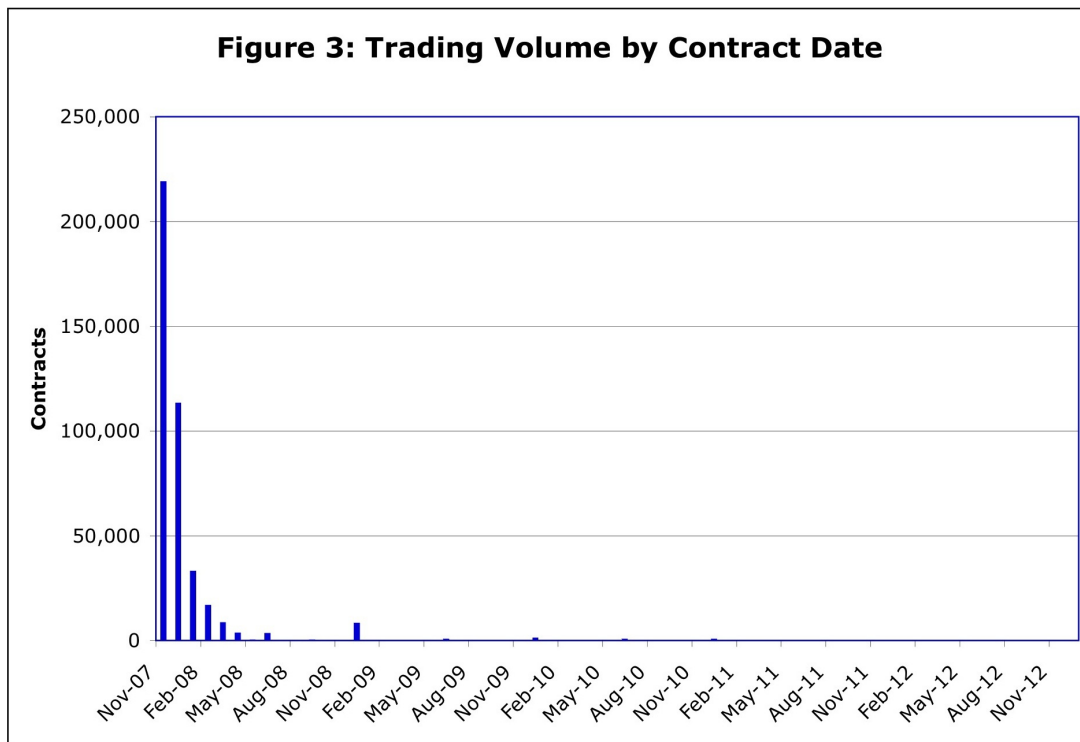
Of course we don't know whether demand is getting the upper hand due to demand growth or supply contraction. But I'm not sure I care. Being the hedonistic type, Peak Availability to Me Personally is all that matters – and it looks as if it is here. It will be interesting to see whether the price of long dated futures continues its trend toward contango and confirms my fears.

### Hedging

So what can I do to protect myself over the long term? For non-commodity derivatives we showed that the replication concept is like a traffic cop keeping spot prices and futures prices in a fairly consistent pattern of relationships (...except when they occasionally depart dramatically and we seem surprised). And in this setup, hedging is quite feasible because I know the value of my futures portfolio will move in lock-step with current prices. (The discerning reader will note a slight gloss-over here but the intuition is accurate.)

For commodities, however, this self-enforced consistency is much weaker, and hedging is a more tenuous prospect unless one is content only hedging the next three months of consumption. The linkage between long-dated futures and spot prices is erratic indeed. As an individual, I may be willing to commit my capital to erratic, long-dated futures just so I have the insurance. For corporations, however, this noise makes quarterly earnings reports messy and no one is interested in that. Instead they buy their insurance one quarter at a time. And like the homeowner who waits until he smells smoke to purchase insurance (he pays a hefty premium), corporations will find themselves completely exposed when the conflagration gets really underway. A useful introduction to energy hedging may be found in [Eydeland and Wolyniec, Energy and Power Risk Management: New Developments in Modeling, Pricing, and Hedging](#), although the presentation tends toward the academic side.

Figure 3 shows volume for Oct. 3, 2007 by contract date to December 2012 using data from [barchart.com](#). (There is also a small volume of contracts to 2015, not shown on this graph.) There is virtually no trading volume for settlement dates beyond 2008!



### The Role of Hedge Funds in Oil Futures

There has been a lot of speculation about the role of hedge funds on futures prices. The presence of hedge funds and other speculative buyers will tend to drive large scale cycles of buying and selling, and create increased market volatility, irrespective of the commodity itself. It seems to me, though, that the level of today's oil is largely governed by production and use rather than speculation - volatility levels just haven't increased all that much. If so, then either production costs are near \$70 or demand for oil significantly outstrips available supply (or some combination

thereof). In either case peak oil, global modernization, and population growth should force oil to continue its current upward trend until there is significant demand destruction (recession, the poor stop buying, pandemic, etc.) or an alternative is found (the Physics is rather stacked against this).

It would be nice to back up the hedge fund picture with hard data. To the best of my knowledge, however, this data is unavailable and any analysis is largely anecdotal. Hedge funds are extremely secretive and go to great lengths to hide their trading activity. An entertaining view into this world may be found in Lowenstein, [When Genius Failed: The Rise and Fall of Long-Term Capital Management](#).

### **Impact of Peak Oil Availability on Other Markets**

We should say something about the cross-linkage between oil and all other economic activity. Cell phones and iPods and didn't arise solely from someone's good idea; they arise from plastics, metals, and highly sophisticated manufacturing processes – all of which require vast amounts of energy to produce and function. And we aren't just talking about luxury items. The energy density of ammonia fertilizer is roughly 50% greater than gasoline! (Do you remember the Oklahoma City bombing?) If energy supply is curtailed, agriculture is horribly exposed and Malthus will have the last laugh.

Finally, as we seek substitutes for fossil energy, we have linked the price of corn and sugar (and by displacement beef, milk, and all non-corn crops) directly to oil. I am reminded of the trader's rule of thumb - in a blowup all correlations go to unity. This means that once Peak Availability hits, there can be no safe haven.

No wonder I sleep so poorly...



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