The Oil Drum
DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

Scarcity Rents and Oil Prices, Again

Posted by Dave Cohen on December 9, 2006 - 11:55am
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Tags: backwardation, contango, crude oil spot price, discounting, james hamilton, scarcity rent [list all tags]

On October 24th, Dr. James Hamilton of Econbrowser commented on The Tragic Consequences of the High Discounting of Oil Extraction [1] in his story Is peak oil irrelevant?

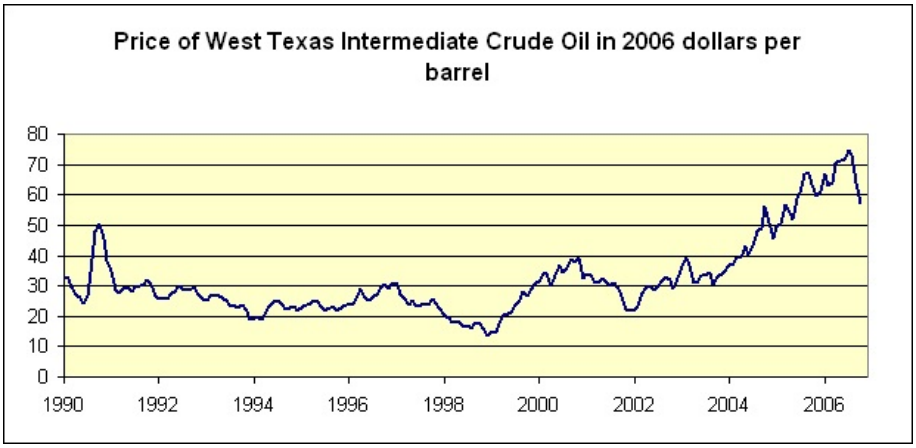


Figure 1 -- Click to enlarge

> If Dave had gazed not at a century of prices but rather at just the last 15 years of the price of oil relative to the PCE deflator, would he have drawn the same conclusion? If all we had was the graph above, it would seem quite natural to conclude that a rising scarcity rent could well be one factor in the recent behavior of this commodity price...
>
> ... I am not at all prepared to dismiss the hypothesis that scarcity rents have indeed started to make a contribution to oil prices over the last five years, and will become more apparent over the next five...
>
> Admittedly, if the oil price should fall from here down to $30, then I'll have to conclude that scarcity rents have had nothing to do with the recent price moves.
>
> But if Dave is right about the geology, oil is not going to $30.

Not knowing of any good evidence to contrary, I'll just make the simplifying assumption that I'm right about the geology.

We'll return below to some of Hamilton's other observations as we consider what meaning to draw from the history of oil prices over the last several years.

As it has turned out, the floor for the oil price shown in *Figure 2* was just above $55/barrel from a high of about $78/barrel — the sharpest drop in the last 15 years as seen in *Figure 1*.

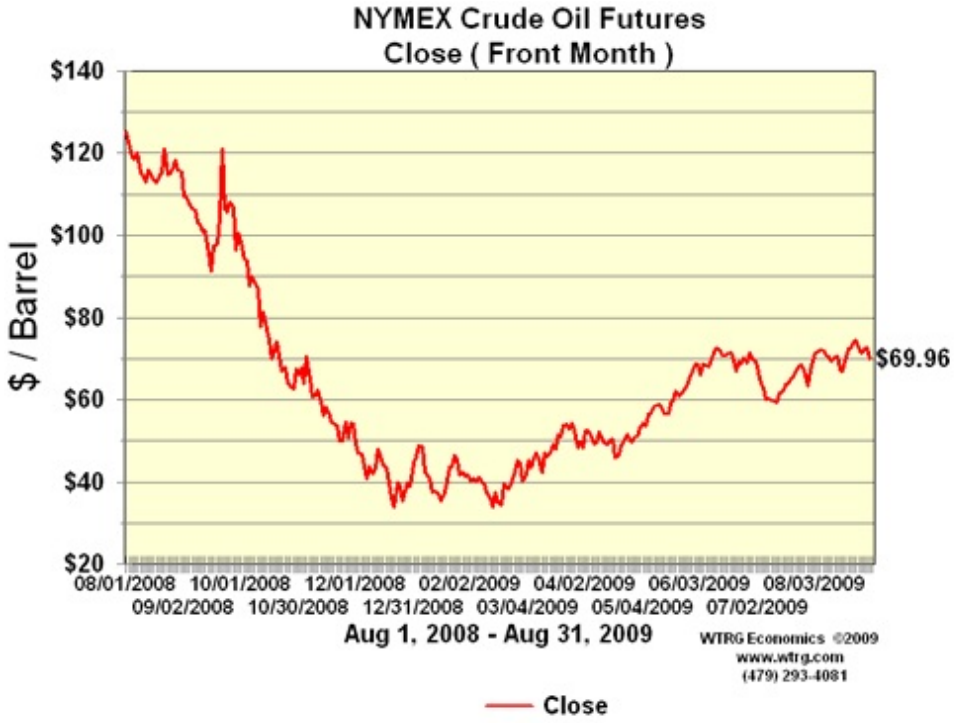


Figure 2

So, the price got nowhere near the $30/barrel level Hamilton cites as invalidating the scarcity rent hypothesis for oil as discussed in [1]. Before re-opening the case as to whether the scarcity rent hypothesis holds, let's review some of our previous work on oil prices in order to evaluate where we are today.

The Future Oil Price Consensus

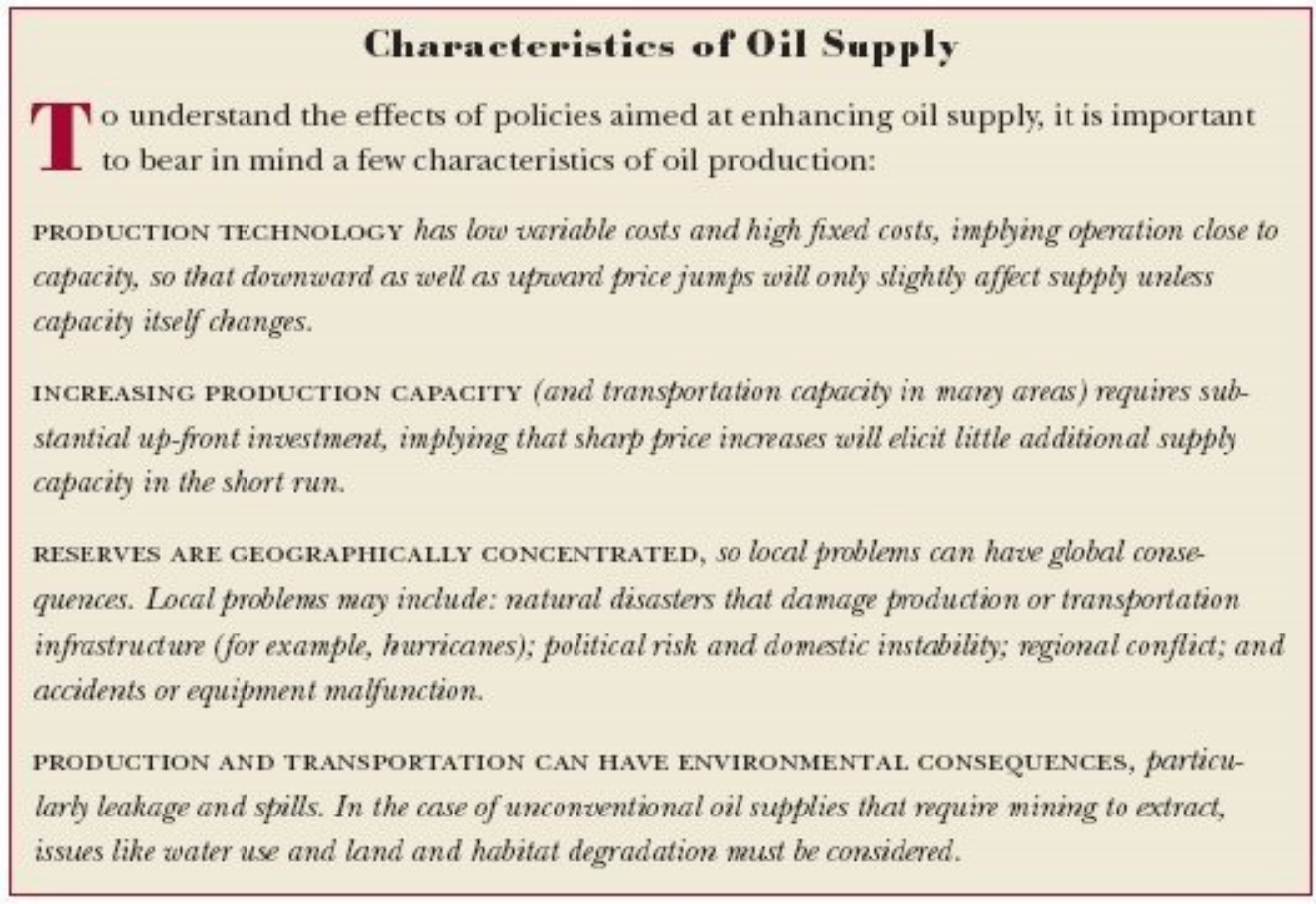
I n Predicting Future Oil Prices (March, 2006) [2], I described the "new orthodoxy", or consensus, about where the oil price is heading. Within the context of developing substitutes for conventional oil, this standard story is summarized nicely in What's the Big Deal About Oil? from the Fall 2006 issue of Resources Magazine

> Although oil prices have risen to more than $70 per barrel in recent months, they have also averaged as low as $20 per barrel within the last five years. Having lived through the oil price spikes--and then dramatic declines--of the 1980s, oil companies typically use an expected oil price of less than $40 per barrel when making long-term investments. **Most current forecasts by government and private analysts project oil prices in the $35-$55 per barrel range over the next two decades**, whereas the large capital investments associated with many alternatives would last for several decades.
>
> Only conventional oil, tar sands, and gas-to-liquids (GTL--conversion of natural gas to transport fuel) are clearly profitable at these prices.... The federal ethanol subsidy of 51 cents per gallon is equal to about $30 per barrel of oil equivalent (that is, energy equal to one barrel of oil), making ethanol competitive at oil prices as low as $20 per barrel of

> oil. Given these market signals, largescale commercial production of Canadian tar sands and ethanol has already begun and is expanding rapidly. One million barrels of oil from Canadian tar sands are being produced per day, a rate that is projected to almost triple over the next decade. U.S. ethanol production, virtually all of which comes from corn, has risen from 106,000 to 250,000 barrels per day since 2000. It is expected to roughly double again by the end of the decade at projected oil prices and with current government subsidies.

Rather than go off on the substitutes tangent, however, I'll stick with main theme of this article — the conventional oil price. One thing should be pointed out, however. There are limits to the growth rate for these substitutes — oil from the tar sands or ethanol. As the world smacks up against those barriers to expansion, the current peak of conventional oil supply will be reflected in its price to an even greater extent than we have seen heretofore. But, I am getting ahead of myself.

Figure 3, from another Resources Magazine article, *Expanding oil Supplies*, is helpful in understanding oil supply from the economist's viewpoint.



Characteristics of Oil Supply

To understand the effects of policies aimed at enhancing oil supply, it is important to bear in mind a few characteristics of oil production:

PRODUCTION TECHNOLOGY *has low variable costs and high fixed costs, implying operation close to capacity, so that downward as well as upward price jumps will only slightly affect supply unless capacity itself changes.*

INCREASING PRODUCTION CAPACITY *(and transportation capacity in many areas) requires substantial up-front investment, implying that sharp price increases will elicit little additional supply capacity in the short run.*

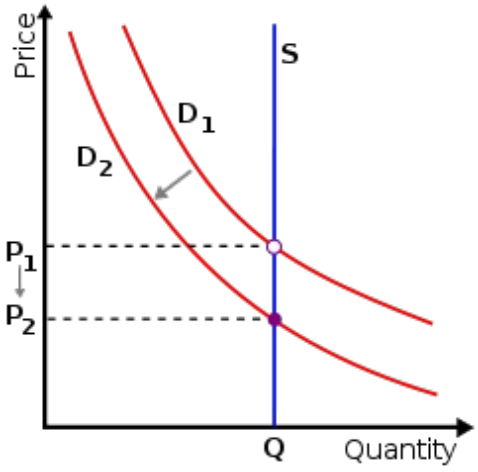
RESERVES ARE GEOGRAPHICALLY CONCENTRATED, *so local problems can have global consequences. Local problems may include: natural disasters that damage production or transportation infrastructure (for example, hurricanes); political risk and domestic instability; regional conflict; and accidents or equipment malfunction.*

PRODUCTION AND TRANSPORTATION CAN HAVE ENVIRONMENTAL CONSEQUENCES, *particularly leakage and spills. In the case of unconventional oil supplies that require mining to extract, issues like water use and land and habitat degradation must be considered.*

Figure 3 — Click to enlarge

Only the first two observations are salient in this context, although the other two points are of interest as well. First, the economics of oil production dictates that production operates very close to capacity. Second, long-lead times and the required large, up-front capital expenditures ensure that, *in the short-term*, capacity expansions are not enabled by oil price increases — *ie*. supply is price-insensitive.

The hypothesis of a near-term peak (prior to 2015) of conventional oil can thus be expressed in economic terms. The *price elasticity of supply* Δ_s, defined as the *percentage change in quantity supplied / percentage change in price*, is and will continue to be < 1 or effectively zero. What this means — in the face of a putative 4 to 5% decline rate in existing production — is that as the price moves upward, the world's ability to bring new conventional oil production on-stream to actually increase capacity will be impaired and, for all practical purposes, this is a permanent state of affairs. What is standardly seen by some economists as a *short-term* constraint is always true after the peak — a positive value > 1 for Δ_s in response to higher prices is simply not possible. At any given point in time, the flat or diminishing supply is perfectly inelastic, just like the available tickets to see Bono & U2 in concert.



When demand D1 is in effect, the price will be P1. When D2 is occurring, the price will be P2. Notice that at both values the quantity is Q. Since the supply is fixed, any shifts in demand will only affect price. From Supply & Demand — Figure 4

Viewing it in these terms, in the current plateau, $\Delta_s \cong 0$. Price has tripled (given the recent slide) since the beginning of 2002 but, nevertheless, the supply expansion ended, as we would expect, despite oil price increases since the plateau's inception, which dates to the beginning of 2005. Generally speaking, however, $\Delta_s \neq 0$. It's positive value will improve by small increments as the oil price rises over time *independent of the decline rate* in the tail-end of the global production curve. Therefore, more oil will become economic to produce as the price rises but this will not offset declines once they have overtaken incremental production gains.

[editor's note, by Dave Cohen] All of this will be obvious to some. I thought that many of our readers might benefit from this explanation — DC

Now, add to this the fact that the *price elasticity of demand* Δ_d is also low, as we have seen. U.S. demand has not shrunk significantly — if at all — while many still developing countries have rising consumption. Increases in Chinese demand continue apace. OPEC would not be defending a $60/barrel floor if prices at or above that level had adversely affected global demand, thus lowering the price significantly. There has not been a global recession. Another way to put this is: the recent plunge in the oil price was not driven by market fundamentals. Many countries (*eg.* Italy, Malaysia, the Phillipines, Peru, Belarus, even India) have been forced to curtail oil consumption but the overall demand picture remains strong.

Let's look again a version of the standard narrative as presented in an article cited in [2], Paul Horsnell thinks we are moving to a sustainable long-term price level from the Oxford Energy Forum, Issue 62 (August, 2005).

> In all, market behaviour this decade has been enough to make it clear what the correct level of oil prices is not, and in particular it has shown that there was nothing magical about the environs of $20. However, that does not in itself help us to tell what the sustainable average level might prove to be. Our view is the sustainable level of long-term prices is that which creates enough investment along the entire supply chain to maintain a reasonable degree of spare capacity, while also ensuring that producing countries are able to maintain some growth in employment and in per capita incomes. That would argue for a long-term price of at least $50, with higher prices needed into the medium term to allow for some catch-up, particularly in the downstream, from the last decade of the 1990s. Prices can of course move to lower levels and indeed in some circumstances to much lower levels. However, they would not be sustainable at those levels into the medium term. Indeed, the real bull case for oil prices would be that we have a period of lower prices and compound the longer-term tightness in the fundamentals of the market.
>
> The view of the sustainable price is of course largely a function of supply and demand responses. Compared to the 1970s, it appears to us that the price elasticities of both supply [Δ_s] and demand [Δ_d] are significantly lower, that the income elasticity of demand is significantly higher. In addition, the increase in the rate of decline of mature non-OPEC production has become a major force in blunting supply response....

There are a couple of interesting observations & assumptions in this quoted passage. First, Horsnell makes the assumption that there will be long-term *sustainable* price. Recent prices above $50/barrel reflect the oil producers playing "catch-up" based on impoverished past levels of investment and long lead times. This would imply that Δ_s is low only in the *short-term*. Given sufficient investment in new supply, enough spare capacity will eventually be brought on-stream to result in a sustainable price of at least $50/barrel. Second, Horsnell believes that a lower price level is *not* sustainable because it would "compound" market tightness by lowering the assumed price elasticity of supply as explained above.

Cracks in the Facade

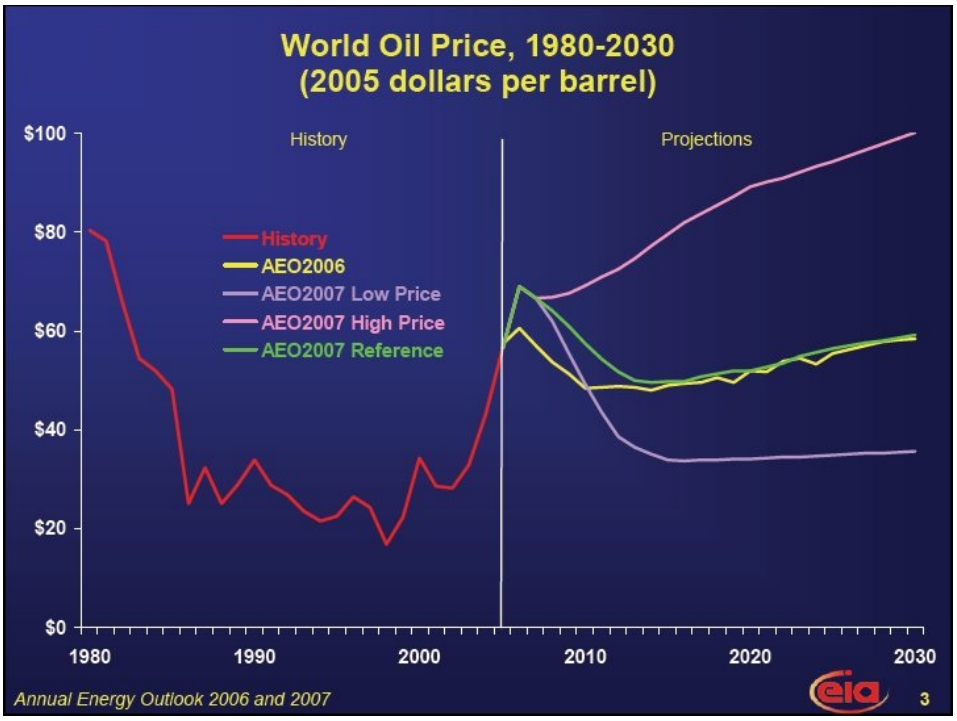
Although CERA remains steadfast, a bulwark against "peakist" pessimism, there are highly suggestive hints that the EIA and IEA are no longer sticking to their story about oil supply and prices. From Oil field delays mean higher 2010 crude prices published December 6, 2006 —

> The US government's top energy forecaster yesterday said it raised its estimate for world crude prices in 2010 by about 20% to near $60 a barrel due to delays bringing new oil fields on line.
>
> African producers like Angola and Nigeria and Latin American states like Brazil will be slower than initially projected in ramping up production from new projects, putting a squeeze on world supply, said Guy Caruso, administrator of the Energy Information Administration.

> "It's clearly going to take longer now to bring on the new supplies and to have an impact on price than we were thinking a year ago," Caruso told reporters.
>
> World crude oil prices are projected to average $57.47 a barrel in 2010 based on 2005 dollars, versus a year-ago estimate of $47.29 a barrel in 2004 dollars, he said.
>
> "The front end of the curve is now much higher than we were thinking a year ago," Caruso said. "We were too ... optimistic of how fast the price would go down" due to new projects coming online," Caruso said.

Caruso's remarks only make sense when considered as a *revision* to the consensus as described in the previous section. There are the usual delays, bringing new capacity on-stream is not going as smoothly as predicted. Therefore, estimates of future prices are starting to rise above those expressed in the standard narrative. Remember, in this context, the current higher prices are the storm before the calm — the price elasticity of supply will increase, today's higher prices will make increased supply capacity possible tomorrow. Or, maybe not.

[Update by Dave Cohen on 12/09/06 at 9:01 AM EDT] I have added the EIA oil price projections from Caruso's presentation on December 5, 2006.



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Then, there are the remarks provided by the IEA chief economist Fatih Birol, as quoted in Investment in Oil Exploration and Production -- An "Above Ground" Factor and further elaborated in the Globe & Mail's Why Big Oil's slick accounting doesn't add up (article purchase required).

> Data compiled by the International Energy Agency show that investment in the oil-and-gas industry was $340 billion in 2005, up 70% from 2000. But cost inflation for goods and services used by the industry accounted for almost all of that increase, according to the IEA, the energy club of 26 of the world's major industrial nations. Adjusted for

> inflation, the oil industry's investment increased by 5% between 2000 and 2005, the IEA, based in Paris, said...
>
> "That's almost nothing; it's inadequate," said Fatih Birol, the IEA's chief economist and principal author of the agency's latest annual World Economic Outlook...
>
> Mr. Birol, the IEA economist, said in an interview that he expects the oil industry's production capacity will slightly outstrip demand through the end of this decade -- or by 1.3 million barrels a day [mbd] -- "if all the projects see the light of day."
>
> Even then, when added to current spare oil-production capacity of roughly two million barrels a day, the total reserve of 3.3 million barrels a day still would be well short of the five million barrels a day needed to put the world into the comfort zone, he said.

Investment has failed us. The new supply will not be there. And the oil price? From Platts' WTI likely to stay above $50 for 'next few years': IEA official —

> WTI crude is likely to remain above $50/barrel for the next few years as spare production capacity remains tight and oil companies battle for access to upstream reserves, the IEA's chief economist Fatih Birol said Tuesday.
>
> "We do not expect prices will come down (below) $50/barrel in WTI terms," Birol told an industry conference in London. "We would like to see prices lower than that," he said, but "it would be a surprising trend if we see prices lower than $50 in the next few years."

As you can see, both IEA and the EIA are singing the same song, a tune that doesn't match the standard price narrative anymore but *is* consistent with a very low (< 1) value for Δ_s, the *price elasticity of supply* of a scarce resource — conventional oil. Oh, don't worry, though, things will work out. The *Good News* has merely been delayed. With this background, let us re-investigate the scarcity rent hypothesis for oil and make some overly bold predictions about future oil prices.

The Sky's the Limit?

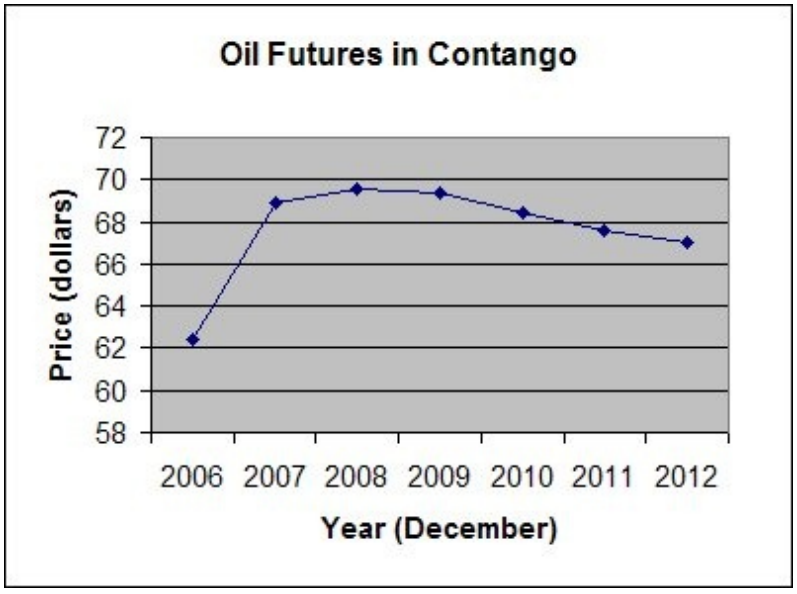
It is worthwhile to quote Dr. Hamilton again, at some length.

> My own view is that, for most of the past century, Dave's inference is exactly correct--the resource exhaustion was judged to be sufficiently far off as to be ignored. However, unlike those whom Dave terms the Cornucopians, **I do not infer that the next decade will necessarily be like the previous century**. Certainly declining production from U.S. oil reservoirs set in long ago. And if one asks, why are we counting on seemingly geopolitically unreliable sources such as Iraq, Nigeria, Angola, Venezuela, and Russia for future supplies, and transferring vast sums of wealth to countries that are covertly or openly hostile to our interests, the answer appears to me to be, because we have no choice. Resource scarcity in this sense has already been with us for some time, and sooner or later the geological realities that governed U.S. oil production are also going to rule the day for the rest of the world's oil producing countries. My expectation has accordingly been that, although scarcity rents for oil were irrelevant for

> most of my father's lifetime, they would start to become manifest some time within mine. And I have been very interested in the question of when...
>
> To be sure, there are some facts that fit a bit messily into that picture. One is that, over the last several years, oil futures prices have exhibited backwardation at some horizons. This is less dramatic now that it was a year ago, with the six-year-ahead contract price of $64 a barrel now above the current $59 1-month-ahead price [on October 24, 2006]. It is not obvious how to reconcile the behavior of futures prices over the last several years with a scarcity-rent explanation, though possibilities to investigate might be option valuation, adjustment costs, or hedging or other risk premia.
>
> A separate set of doubts of course arise from the dramatic plunge in oil prices over the last few months, which at a minimum must reflect either some substantial new information about the long-run fundamentals or else confirm that some factors other than scarcity rent have been contributing to the oil price peak of the last year.

Addressing Hamilton's second point, the dramatic plunge in oil prices appears to be over. Clearly, other factors, such as the geopolitical risk premium which pushed the oil up to $78/barrel last summer, have contributed to the price. As to the fundamentals, the only new information we have at present is that supply capacity will remain tight in the foreseeable future — this is now admitted by the EIA and the IEA. On the other side of the equilibrium curve, demand is still robust and growing. Therefore, the oil price must rise over time.

Hamilton's first point concerns *backwardation* in the oil market *ie*. the state where the current front-month spot price exceeds oil futures prices further out in time. The opposite is *contango*, which is the current state of things as shown in *Figure 5* below.



Futures Prices ($/barrel) on December 5th
Figure 5

Based on a hypothesis of Jeff Vail, Professor Goose wrote about Peak Oil Contango? in March of this year.

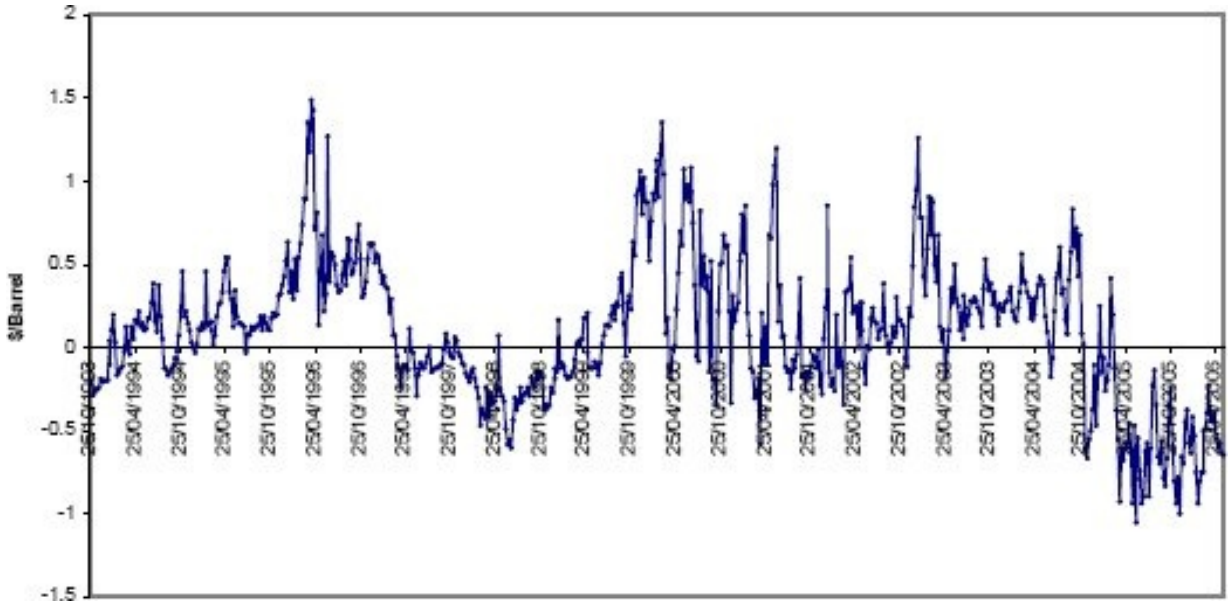
> ... According to economic theorists, backwardation is not normal, and is suggestive of

> supply insufficiency. For some time now, crude oil markets have been in backwardation.
>
> Normally when a market switches from temporary backwardation back to contango, it is a result of the short-term supply problem that caused backwardation being resolved--that is, the spot price decreases. The interesting point from a Peak Oil perspective is this: *a shift in fundamentals, such as a steady decline in world oil production, will make the commodity increasingly expensive in the future and will cause a market in backwardation to shift to contango without a decline in the spot price*.

Backwardation suggests a temporary supply deficit which moves the oil spot price above the futures spread. When the shortfall is resolved, the spot price falls and the backwardation condition disappears. As Hamilton notes, the scarcity rent hypothesis implies that the futures prices should always be in contango as they are now. According to the Hotelling rule, the oil's future value $v(t_{i+1})$ should equal it's present value at $v(t_i)$ + the rate of interest.

Have the oil markets moved into contango without a concomitant drop in the oil price? According to Bassam Fattouh's Contango Lessons, an interesting thing has happened in the last 18 months.

> However, one striking feature in the current market has been the prolonged contango in the WTI forward curve. Figure 1 below shows that during the last 18 months or so, the nearby (delivery) futures contracts have been trading at a discount to the second month futures contract.



First Month Forward minus Second Month Forward
Figure 6 — Click to enlarge

Fattouh goes on to say —

> Various explanations have been put forward to explain the current contango in crude oil markets. Advocates of the peak oil hypothesis consider that the current transition from backwardation to contango is due to a greater acceptance by market participants of peak oil. Simplifying greatly, peak oil theory predicts that oil production will reach a peak some time in the very new future after which production would start to decline. In

> the face of an expected growth in global demand, this implies that oil prices for future delivery should rise faster than prompt prices. This would imply a contango structure with the contango widening at the later segments of the forward curve as impending shortages become more acute ahead in the future. However, this implication is not supported by the data: the term structure of futures contracts for long term maturities is in backwardation and the volume of outstanding contracts is relatively low which indicates that investors place little weight on peak oil predictions. After all, if market participants adhere to the view of peak oil, then they would have the opportunity to make large profits by buying the longest maturity crude oil futures contract that the market allows.

While it can certainly be acknowledged that investors have placed "little weight on peak oil predictions" in the past, perhaps they are starting to do so now. Indeed, in September, when Fattouh's analysis was done — during the midst of the recent sharp price dip — longer term futures were in backwardation. However, they are now in contango (*Figure 5*) and the oil price has risen since mid-November. This behaviour is consistent with the peak oil view as laid out by Professor Goose. Needless to say, Fattouh's own data show that the second month forward has been in contango for quite some time. We should bear in mind that using a *futures-spot spread model* (discussed in [2]) to predict the future spot price has large associated uncertainties, as we would expect.

Conclusions

Whether a *scarcity rent* for oil is now part of its price is unknown at this time. Like the peak itself, an explanation along these lines can only be offered in retrospect. Also, nothing I've said here precludes future incremental supply increases before the peak of production. The price rises of the last 5 years have taken place outside any major oil shocks, though there have certainly been significant "above ground" disruptions as in Iraq or Nigeria. The expected large new investment in the oil supply has not yet occurred. The EIA and the IEA are now starting to acknowledge supply inelasticity as the oil price rises. According to any reasonable interpretation of the fundmentals at this time, there appears to be no reason why the future price of oil should not climb and climb. Despite great short-term volatility, which is really only an indicator of spare capacity tightness in the market, no persuasive evidence exists so far that the price rise since early 2002 will not be a permanent feature of the world we live in. As to next year's price, I believe the upward trend will continue as it has unless a major geopolitical event or a severe global economic downturn throws us into uncharted water.

Dave Cohen
Senior Contributor
The Oil Drum
davec @ linkvoyager.com