ROBERT F. McCULLOUGH, JR.
MANAGING PARTNER

A Forensic Analysis of Pickens' Peak:

Speculators, Fundamentals, or Market Structure

Robert McCullough
McCullough Research, Portland, Oregon
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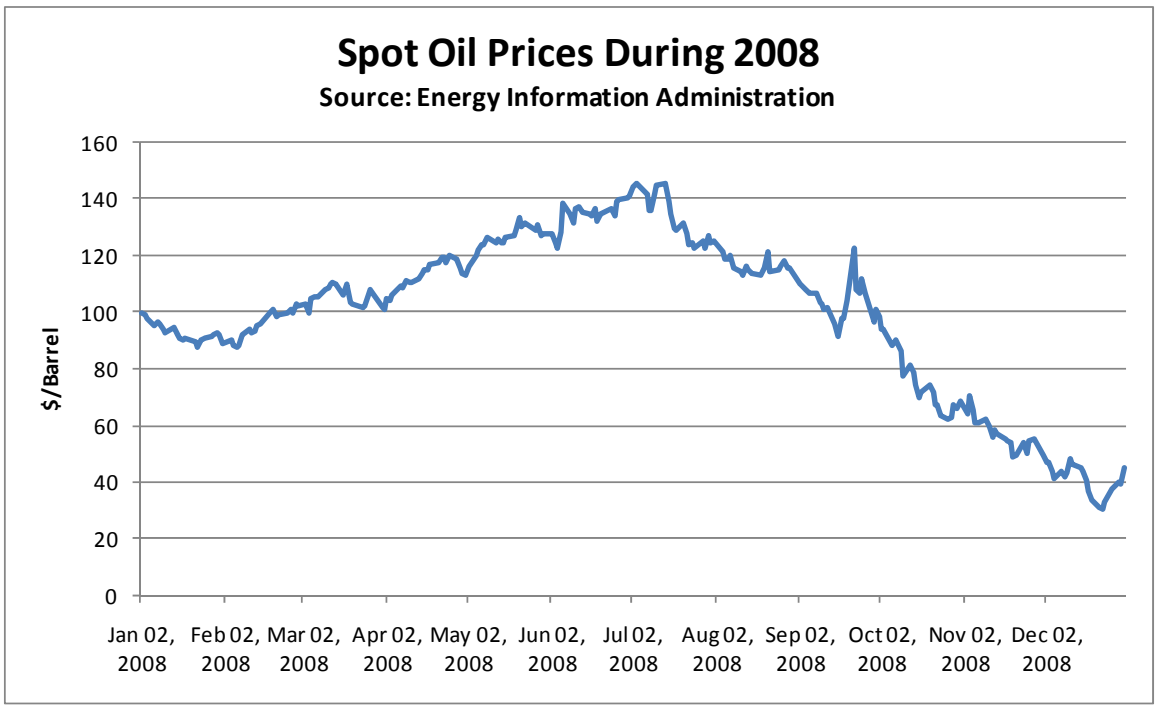
America's most significant import, crude oil, has such strong connections with natural gas and electricity that it affects the entire economy. It is also the import we know the least about. U.S. regulators do not collect data on any spot transactions, and data is available on only a portion of forward transactions. Although we fear that the oil market may have become dominated by speculators, we do not know who they are, or their possible impacts. We do know that oil prices are frequently anomalous. For example, on March 15, 2009, OPEC decided to maintain output at levels agreed to before the onset of the current recession. This was good news for oil consumers. Unfortunately, however, oil prices have since risen significantly.

On January 30, 2008, T. Boone Pickens predicted that oil prices would reach $100.00 a barrel during the first half of 2008.[1] By July 23, he predicted that oil prices would

[1] T. Boone Pickens shares his views on energy, politics, the Olympics, OSU's new president, *The Daily Oklahoman,* January 30, 2008.

reach $300.00 a barrel by the year 2018.[2] In doing so he was echoing Kenneth Deffeyes.[3]

But oil prices in 2008 did not obey Mr. Pickens. On July 3, oil peaked at $146.00 a barrel, only to fall precipitously to a yearly low of $31.00 a barrel on December 22.



At McCullough Research, we have taken to calling the anomalous prices in 2008 "Pickens' Peak" in honor of Mr. Pickens' forecasting initiatives. It is clear from the parallel to the earlier Hubbert's Peak prediction that we believe there are better explanations for last year's peak in prices than a global shortage of oil.

[2] Pickens warns of $300 oil, Herald News Services, July 23, 2008.
[3] Hubbert's Peak, Kenneth S. Deffeyes, 2008, page xii.

Because of the linkages among the nation's fuel markets, retail gasoline, natural gas, and electricity followed similar trajectories during 2008. Pressure on household budgets accentuated the sub-prime financial crisis, and the change in automobile economics brought a steep decline in car sales.

While oil is arguably the U.S. economy's most important commodity, it is ironic that no agency of the U.S. government has been assigned the task of investigating and explaining the extraordinary price changes of last year.

Current responsibilities are allocated among the Federal Energy Regulatory Commission (pipelines), the CFTC (some, but not all, forward contracts), and the EIA (forecasting.) On June 10, 2008, the CFTC announced the formation of an interagency task force, including the CFTC, the Federal Reserve, the Treasury Department, the SEC, the DOE, and the Agriculture Department, to study commodity markets. The task force expeditiously published an interim report, but apparently stopped its activities soon thereafter.[4]

It is surprising that not one of the three lead federal agencies has expressed much interest in Pickens' Peak. A review of materials issued by FERC, which regulates natural gas and electricity trades, but not oil trades, also reveals little interest in the dramatic run-up in the price of oil in the first half of 2008.

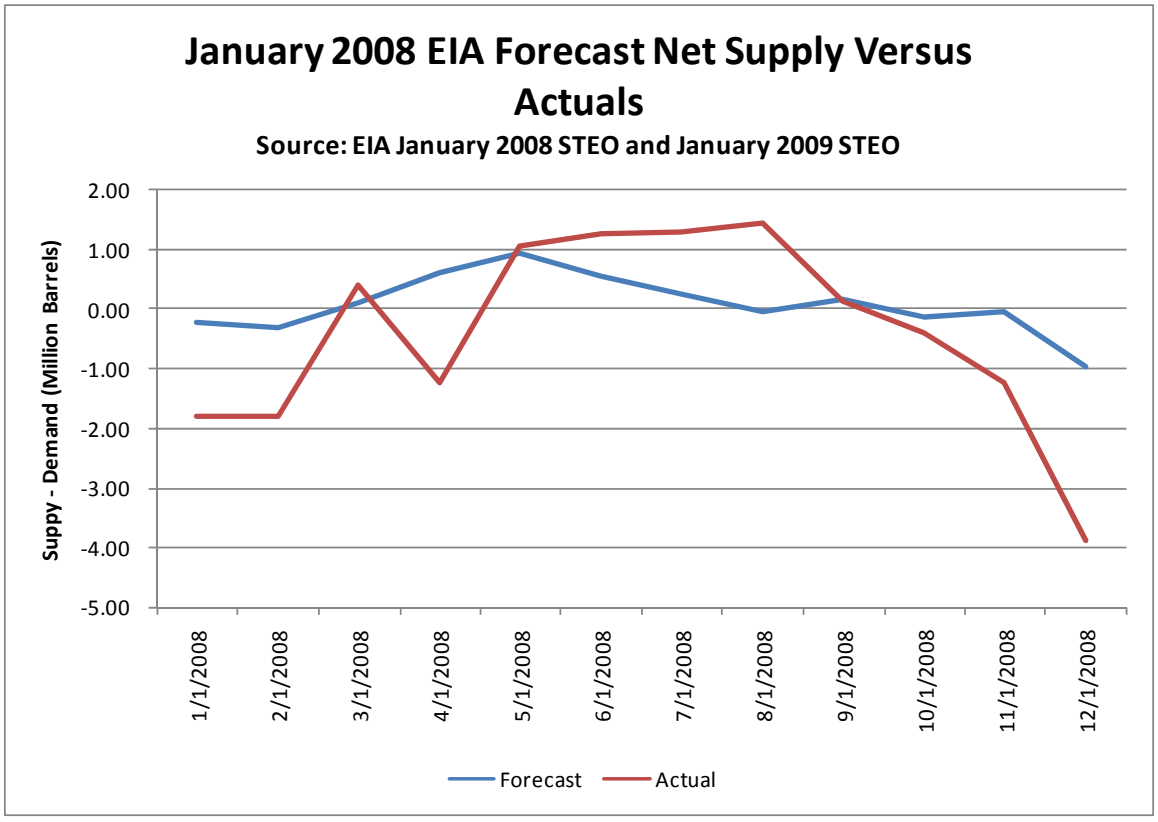
The EIA's Short-Term Energy Outlook (STEO) Forecasts

The preeminent independent forecast of world oil markets is performed monthly at the Energy Information Administration. Curiously, this resource was largely ignored

[4] Interim Report on Crude Oil, Interagency Task Force on Commodity Markets, July 23, 2008.

by apologists for the 2008 price spike, who relied instead on anecdotes concerning exchange rates, Chinese and Indian oil imports, and surging U.S. demand. Now that data from 2008 is in hand, it is useful to compare the EIA's quantity forecasts with actual historical quantities.

On January 8, 2008, the STEO forecasted supply shortfalls at the beginning and the end of 2008. Actuals matched these forecasts quite well:



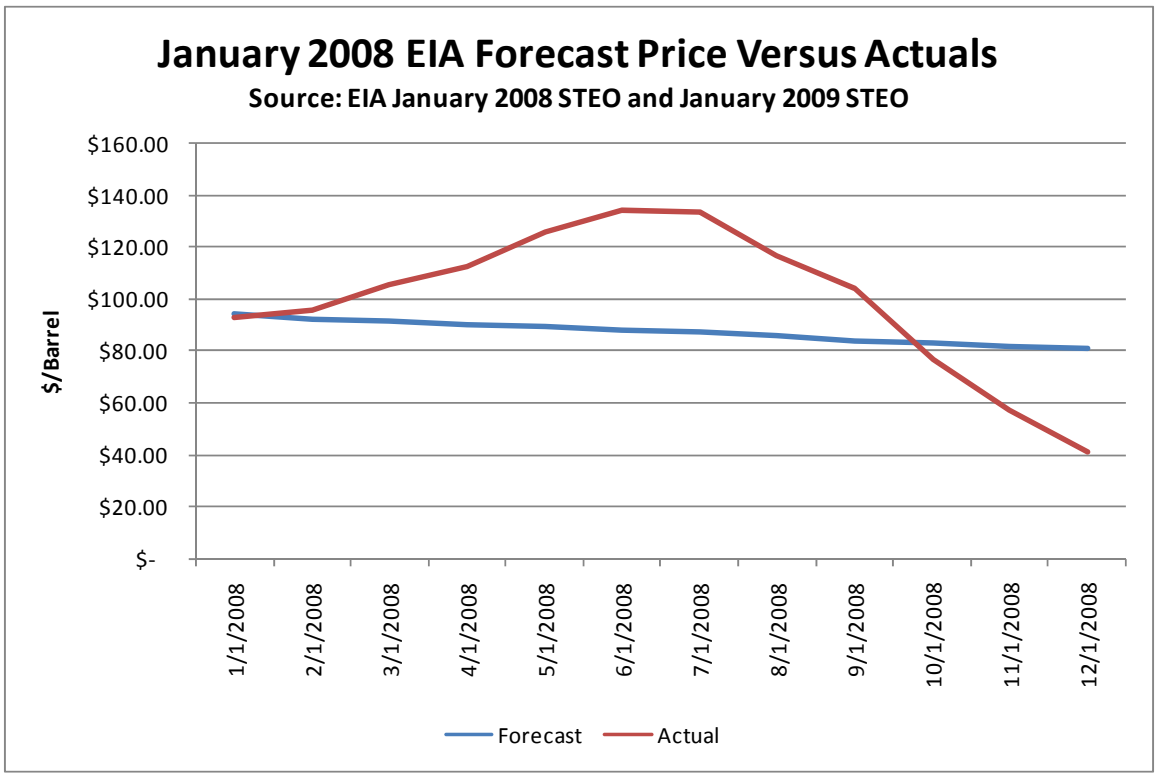
The chart shows the EIA's forecasted additions (blue line) to world oil inventories in the spring and early summer of 2008, followed by drawdowns in the fall and winter of 2008. Actual data (red line) shows that while the EIA accurately predicted the ba-

sic pattern, it underestimated the inventory build-up during the price spike and the reduction in inventories during the autumn when oil prices were falling.

It is worth noting that the EIA had correctly forecasted all of the fundamentals that supposedly drove up last year's market prices, including:

- Demand from China (which did not change materially during the run-up in prices)[5]
- Demand from the U.S. (which declined during the run-up in prices).[6]

Yet the EIA's price forecast was very poor:



[5]EIA STEO Table 3a, http://www.eia.doe.gov/emeu/steo/pub/contents.html
[6] Ibid.

Examining the numbers the way a statistician would approach this problem, the EIA's forecast of quantities is statistically significant at 99%, i.e. very good. The EIA's forecast of prices, however, is not statistically significant at any level.

We may conclude therefore that the basic assumptions underlying the EIA's price forecast require careful examination. It appears likely that price responses to changes in supply and demand are more complex than those modeled in the EIA's price forecast.

The Economics of Storable Non-Renewable Resources

Oil is the ultimate example of a storable limited commodity. Generations of economists have written papers on the use of optimal control theory to prove that the term structure of oil prices should reflect the risk-adjusted cost of capital. The logic of the proof is simple. The owner of a finite resource will plan its extraction based on maximizing profits. If the current price is above the long-term expectation, it is optimal to sell the entire resource today. In the alternative, if the long-term price is above today's price, it is best to wait.

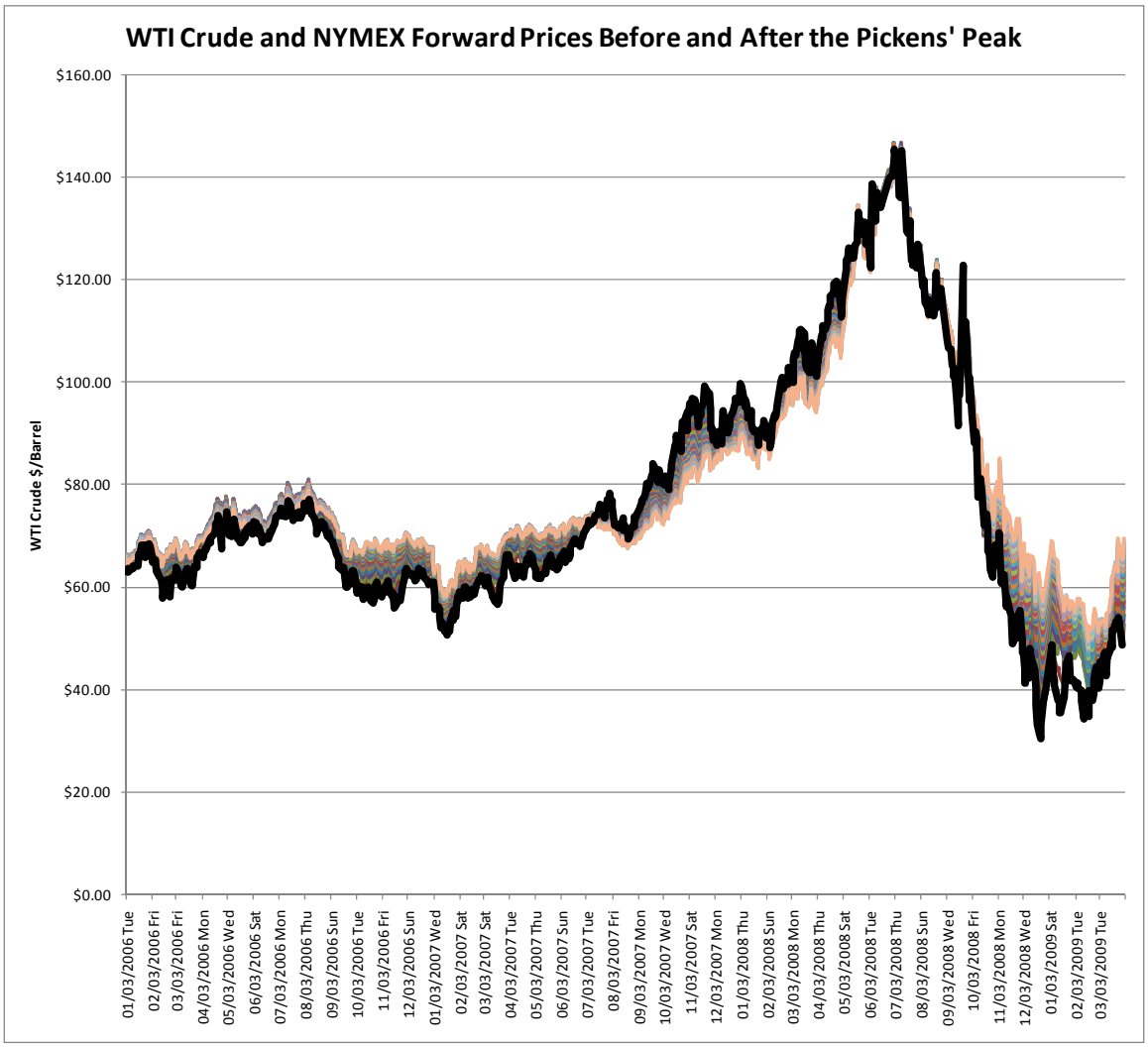
In a world with perfect information, we would expect to see the term structure of oil reflect the risk-adjusted cost of capital. Speculators would have little impact on the outcome since in perfect competition they would have little impact on prices. However, problems abound in applying this perfect world to the one we actually inhabit.

The first problem is the presence of perfect information. Few of us can agree on the long-term levelized price of oil. Economic logic would tie it to ready substitutes – ethanol and oil shale – but we have a very doubtful command of the costs of either.[7]

The pricing of forward contracts is also in some dispute. In a liquid world, the cost of forward contracts should reflect the price forecast for oil plus a risk premium. The risk premium should be positive if demand for longs – future supplies – exceeded shorts and vice versa. The quantity demanded should not be an issue until the demand presses against the risk limits of entrepreneurs willing to sell the contract.

The picture of term structure prices during 2008 differed from the conclusions of many pundits. Surprisingly, the term structure of forward contracts in oil largely disappeared during the Pickens' Peak.

[7] Ethanol's costs are easily derived, approximately $50/barrel, but the market structure of ethanol is confused by a bewildering framework of subsidies. Oil shale, and its poor cousin, orimulsion, are even harder to price given the environmental externalities.



This chart shows spot prices (EIA) against NYMEX forward prices from January 2006 through March 2009. The heavy black line represents spot prices. The colored lines show forward prices for contracts deliverable from one month to five years. The term structure changes over time. In 2007 and the first few months of 2007, forward prices were lower than spot prices. After the Pickens' Peak, the term structure returned to our traditional preference, greater than spot.

During the peak, spot and forward prices change in lockstep. This is not an unusual market reaction to extremely volatile markets. The heavily manipulated electricity markets along the West Coast of the U.S. and Canada showed the same behavior in 2000 and 2001. The relationship between spot and forward in these cases is known as "curve shift" – reflecting the daily adjustment of forward prices to that day's change in spot prices.

We have very little data to explain the behavior of spot and forward prices during the Pickens' Peak, other than monthly fundamentals from the EIA, prices from NYMEX, and a variety of difficult-to-understand, incomplete statistical information from the CFTC.

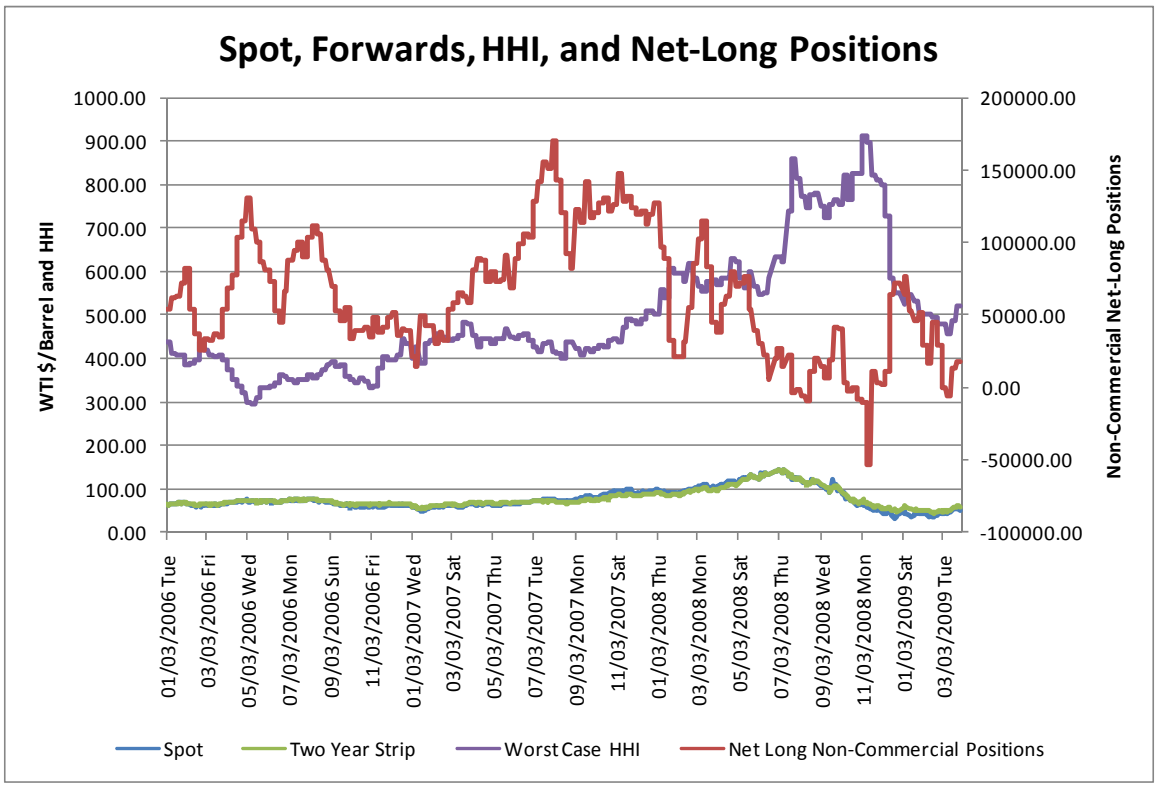
The CFTC's reports use terminology that dates to the 1920s. Their Commitments of Traders report identifies a variety of statistics for commodities on a number of exchanges. It is incomplete, because for years CFTC jurisdiction has been limited by budget and lobbying. Two sets of statistics are interesting, however:

1. Positions of Non-Commercial Traders

2. Gross Concentration

In CFTC parlance, non-commercial means the traders who do not take positions on behalf of producers or consumers. Without being pejorative, they are speculators, where the term has the same meaning as everyday investments in real estate we do not intend to inhabit or the stock of companies we do not intend to run. Gross concentration is the CFTC's version of the Herfindahl-Hirschman Index (HHI). We can

chart the evolution of net positions and market concentration from 2006 through first quarter 2009:



We have taken the liberty of translating the CFTC's concentration statistics back to the more commonly used HHI.[8] The net-long position of non-commercial traders reached a peak in mid-2007 and then fell through the fall of 2008. It should be noted that this is only the reported position on the NYMEX and does not include the majority of forward contracts. The Worst Case HHI climbs over this period and then declines significantly in fall 2008. Both statistics are consistent with the presence of

[8] There are many ways to this transformation. I have chosen the worst case: the HHI that would result if the components of the CFTC concentration ratios reflected a large market participant and several smaller participants (described as a "Worst Case HHI" in the chart).

large market participants dominating the market during the run-up of prices and then liquidating their positions after the high prices in July.

The Economic Theory of Oligopolistic Markets

The heart of the problem is the assumption that the global crude oil market reflects a competitive market with a large number of buyers and sellers. Little research has been performed concerning the degree of competition in the oil market. Although we know that mergers have reduced the number of very large players, there is almost no real data about the degree of market concentration. Understanding the degree of competition is crucial, because economic theory gives very different predictions under different market structures:

1. **Perfect Competition**

   In perfect competition many buyers and many sellers make it impossible for any one supplier (or a small group of suppliers) to set prices. To forecast prices in perfect competition, economists rely upon the years of experience that have established the use of supply and demand curves.

2. **Oligopoly**

   Oligopoly is a market with relatively few sellers. Forecasting prices in an oligopoly is more complex since a few large players can – and do – exert control over prices.

Inventories are important in an oligopoly. A market with only a few large participants is likely to experience situations where market participants will accumulate in-

ventory rather than sell their products at prices they see as less than their long-term prospects.

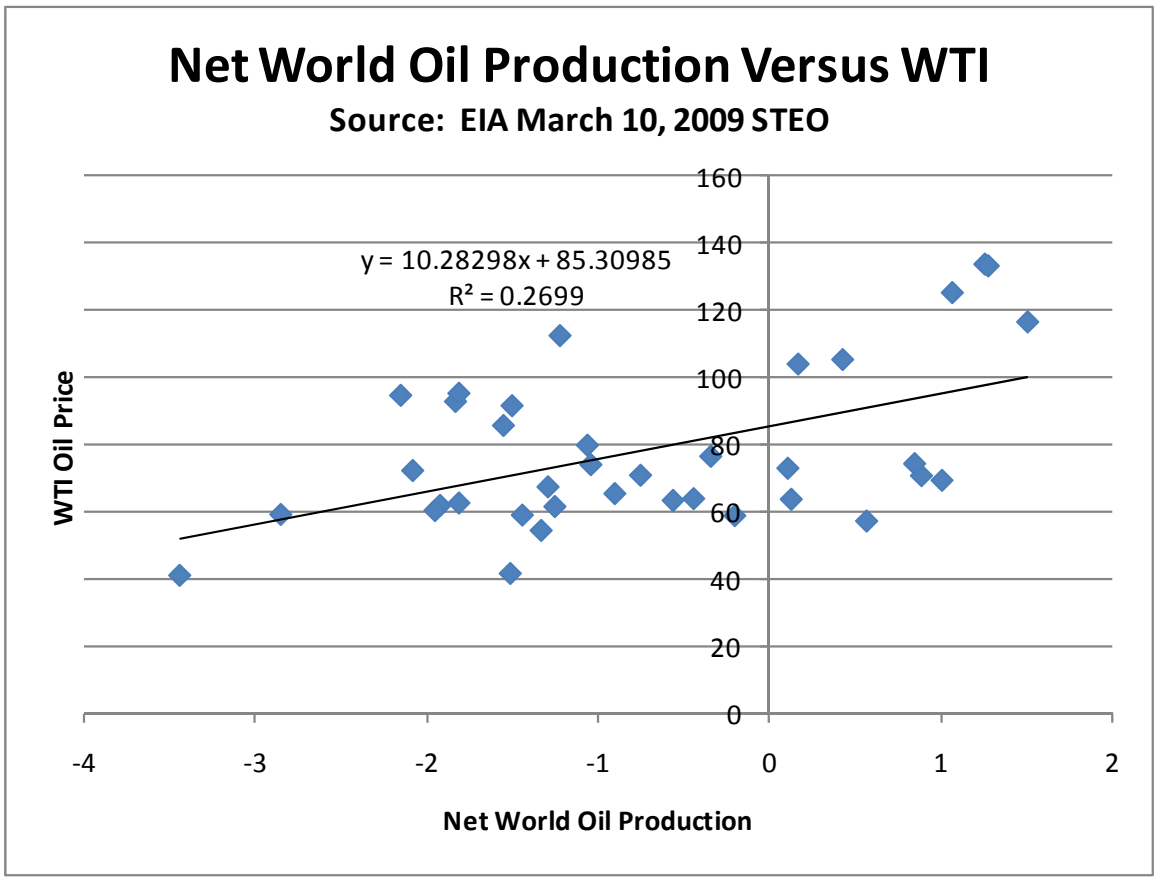
An extreme case of oligopoly is a market with a few pivotal suppliers. A pivotal supplier can exert strong control over prices because its output is absolutely required to meet demand even after all alternative supplies have been purchased.

In a dynamic economic model we would expect an oligopolist in a market with increasing prices to accumulate inventory to sell during later periods. If the market for oil experienced prices increasing 6% per month – as happened in the first six months of 2008 – only a very altruistic competitor would not be tempted to increase its inventory in anticipation of higher prices later. If other competitors made similar decisions, their inventory changes would also alter the supply of oil available to the market and increase oil prices.

If a pivotal supplier was present, its inventory decisions could directly set the price in the market. Decisions to withhold supply are frequently observed in the nation's wholesale electricity markets. This was the case during the Western Market Crisis of 2000-2001 when major suppliers in California reported only 50% availability for their plants during periods of high demand.

Given the data now available from the EIA, the assumption of oligopoly is a better candidate than perfect competition for a model of the world oil market. Inventories rose during the period of rising prices and then fell when prices were falling.

Statistically, the relationship between prices and net world production has been positive since 2006:



Increases to world inventories (production larger than current needs) have been correlated with higher prices.[9] This is more consistent with oligopolistic behavior than perfect competition. Given the extreme levels reached during July 2008 it is very possible that the oil market had one or more pivotal suppliers.

[9] The coefficients and R^2 have been corrected for serial correlation.

Testing the Data

Was the Pickens' Peak the product of fundamentals, speculation, or market structure? The three explanatory variables (net world production, speculators' net positions, and the worst case HHI) are highly significant (99.9%) in GARCH regressions against both spot prices and a twenty-four month strip of forward NYMEX prices.[10]

ARCH family regression

Sample: 1 - 801 — Number of obs = 801
Distribution: Gaussian — Wald chi2(3) = 6362.52
Log likelihood = -2602.388 — Prob > chi2 = 0.0000

	Coef.	OPG Std. Err.	z	P>|z|	[99.9% Conf.	Interval]
twoyearstrip						
netlongnon~s	.0000892	2.47e-06	36.10	0.000	.000081	.0000973
worstcasehhi	.0881983	.0012621	69.88	0.000	.0840454	.0923512
networldpr~n	4.210875	.0677801	62.13	0.000	3.987842	4.433907
_cons	32.08848	.5608717	57.21	0.000	30.24292	33.93405
ARCH						
arch						
L1.	1.009329	.1441439	7.00	0.000	.5350196	1.483638
garch						
L1.	.0514633	.0596498	0.86	0.388	-.1448161	.2477427
_cons	1.088519	.2207647	4.93	0.000	.3620873	1.814952

Given the high correlation between spot and forward prices, it is not surprising that the GARCH results for spot are effectively identical. The anomalous relation between supply and price continues to be present in the GARCH regression, although the coefficient is somewhat lower.

[10] The use of OLS in any time series is always problematic. Since this data is particularly unlikely to have error terms that are independent and identically distributed, Generalized Autoregressive Conditional Heteroskaedasticity models allow the error term to vary over time, a reasonable assumption given the volatility of recent events in oil markets. The statistics are very stable over OLS and OLS corrected for serial condition.

A more interesting question concerns the impact of speculators on the term structure. As discussed above, the hypothesis that speculators had raised the cost of forward contracts appears inconsistent with financial theory. It appears unlikely that increasing risk premia caused the Pickens' Peak, because there was effectively no term structure during the peak. The simplest way to approach this question is to eliminate the spot and twenty-four month strip price variables and replace them with a variable equal to forward prices minus spot prices. We have no a priori beliefs concerning the impact of current production on forward risk premia, so this variable is also dropped.

ARCH family regression

Sample: 1 - 801 — Number of obs = 801
Distribution: Gaussian — Wald chi2(1) = 573.51
Log likelihood = -1958.154 — Prob > chi2 = 0.0000

	Coef.	OPG Std. Err.	z	P>|z|	[99.9% Conf.	Interval]
delta						
netlongnon~s	-.0000273	1.14e-06	-23.95	0.000	-.000031	-.0000235
_cons	5.893198	.0802791	73.41	0.000	5.629037	6.157359
ARCH						
arch						
L1.	.6591728	.0842491	7.82	0.000	.3819488	.9363969
garch						
L1.	.4007306	.0462841	8.66	0.000	.2484315	.5530297
_cons	.1120789	.0270969	4.14	0.000	.0229158	.2012421

While the statistics necessarily reflect the fragmentary nature of the underlying data, they clearly do not reject the hypothesis that fundamentals, market structure, and speculation affected price. They also appear consistent with a market power explanation. The role of speculation is more complicated. The data fails to show the theory that speculation "used up" the risk tolerance in the market and caused higher risk premia. In fact, the opposite appears to be the case.

Conclusions and Recommendations

Pickens' Peak is not correlated with any supply shortage or demand spike. The opposite appears to be true – world inventories increased as prices were increasing and decreased as prices fell. This is far more consistent with an oligopoly where market participants can exert some control over prices. CFTC data indicates that market concentration increased along with the net positions of "non-commercial" market participants. This is also consistent with a market structure explanation.

Were speculators the problem? The data doesn't easily support speculators running up the risk premia over the Pickens' Peak. To the contrary, the term structure flattened out during this period – exactly the opposite of what we would expect if speculation was the cause.

Our paucity of data on oil markets is the real problem. Forward markets are surveyed incompletely and spot markets are not surveyed at all. The period of Pickens' Peak does not support the theory that supply and demand were operating normally. If this is a very large and critical market structure problem, it calls for appropriate policy instruments, including budgeting and staffing for effective market surveillance. In addition we should select a lead agency and begin to accumulate spot market transactions, while remembering that data is the best protection against oligopolistic abuses.