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Black Gold and Fool's Gold: Speculation in the Oil Futures Market*

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Black Gold and Fool's Gold: Speculation in the Oil Futures Market

On its face, nothing looks more like a classic bubble than the accelerating inflation of the oil price between 2003 and mid-2008, followed by a sudden collapse in late 2008. Starting from $30 per barrel, the price climbed fitfully but persistently to $100 per barrel at the end of 2007 and then shot up above $140 by July 2008, only to collapse below $40 by the end of 2008. Clearly the price spiked dramatically, but was it a bubble?

A large number of people have pointed their fingers at the growing flow of money into financial instruments tied to the oil price. These flows, they argue, pushed the oil price up and away from its fundamental level. The bubble burst when the general financial market collapse put an end to this dynamic. Some who make this argument speak with blanket disapproval of "speculation" and "speculators" because they are not part of the "real" oil business. Some go further still and suggest that financiers specifically "manipulated" the oil market. But the theory that the oil price spike was a speculative bubble driven by financial flows requires neither disapproval of purely financial investments in oil nor a judgment about motives. The thing about asset bubbles is that they arise naturally, so to speak, in any economy sophisticated enough to develop financial assets.

Among economists there is a prevailing skepticism toward the view that the oil price spike was a bubble.[1] They point to the fact that the underlying fundamentals of supply and demand changed significantly in this period.

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I want to thank Ramón Espinasa of the Inter-American Development Bank, who documented changes in key fundamental factors over the time horizon. This includes the declining crude oil production in developed countries and the rapidly increasing demand from the developing countries.

1. There are also economists who are not skeptical and who have argued that the oil price spike was clearly a bubble, including Eckaus (2008).

Economic growth was unexpectedly rapid and persistent in several developing countries, like China and India, which increased the demand for oil. Simultaneously, the supply of oil from some key sources fell, despite the rising price, and new sources were slow to appear. The only way to equilibrate this increasing demand and shortfall in supply was with a sharply rising price.

The argument that demand was the fundamental factor driving the price of oil up so sharply is bolstered by the fact that so many other commodity prices were rising dramatically at the same time. Many of these commodities are not traded on futures exchanges and are not assets that can be the subject of a bubble. These include various types of iron and steel and fabricated products, as well as cement. The price of things like engineering services increased dramatically as well.[2]

Rising global demand was clearly driving many prices sharply upward, and this was probably a major factor for the price of oil. The only question is whether changes in demand and supply curves for oil account for all of the movement in the price. Since there is no widely accepted measure of the global demand and supply curves for oil, it is difficult for economists to clearly demonstrate that the spike in the oil price is entirely determined by fundamentals.

A related source of skepticism among economists is the question of the missing stockpiles of oil. This is the dog that did not bark in the mystery of the oil price spike. If the price of oil were to be driven above its fundamental level at which supply and demand were matched, then consumers would cut back on use and producers would produce more. The quantity supplied would therefore exceed the quantity demanded, and the difference would have to go into a stockpile that someone (namely, the financial speculators) would be holding in hopes of a higher price in the future. Although the actual facts of supply and demand may be difficult to pin down, barrels of oil in storage are easy to count. No such stockpiles arose throughout the 2003–08 period, ergo financial speculation was not the cause of the oil price spike. It must have been supply and demand.

The economist's skepticism is generally a healthy one, but in this case, it is too dismissive. It overlooks how paper oil markets have been transformed. As I explain below, successful innovations in the financial industry made it possible for paper oil to be a financial asset in a very complete way. Once that was accomplished, a speculative bubble became possible. Oil is no different from equities or housing in this regard.

2. I have documented the large inflation in the cost of building nuclear power plants over this period; see Du and Parsons (2009).

The next section of this paper documents what is known and what is not known about the growth of financial investments in oil derivatives from the mid-1990s through 2008. The paper then applies a widely employed model of oil price movements to explain the dynamics of the term structure of oil futures prices. Next, I extend this model to an analysis of the returns to financial investments in oil derivatives and explore the historical relationship between oil price movements and profits from investments in oil derivatives. This relationship changed beginning in 2003, which may have generated the type of dynamic in beliefs that is a key feature of speculative bubbles. Moreover, the evolution of the term structure since 2003 undermines the argument that a bubble needs to be accompanied by an accumulation of above-ground stockpiles of oil. The final section concludes.

Assessing the Size of Financial Investments in Oil

How large are the financial investments in oil markets? Answering this question requires sorting through exactly which type of financial investments are to be covered. By far the largest financial investments in oil markets are made through equity and debt ownership of the many, many companies engaged in oil exploration, production, refining, and marketing. A good number of these companies are state owned, but many are privately owned and many publicly traded. State claims on oil revenue in the form of royalty rights and tax claims are another major form of financial investment. However, none of these vast forms of investment in oil are what is really meant by the question. Instead, most questioners really want to know the scale of the pure financial bets on the price that are made through the futures market or related channels.

In the sections below, I document the growth in exchange-traded futures and options. I also explain off-exchange trading and why so little is known about its size. Another important issue is the shifting share of trading by hedgers and speculators and the size of a particular type of speculative activity, namely, index trades. Finally, I benchmark the scale of this growing financial activity against the size of investments in the physical market for oil.

Open Interest in Exchange-Traded Futures

The New York Mercantile Exchange (NYMEX) is the major exchange on which oil futures are traded. One metric to consider is the value of the total open interest in its oil futures contracts. The open interest is the total number of bets in play at a given point of time, with someone being on the long side of the bet and someone else being on the short side. Total open interest rose from over 350,000 contracts in mid-1995 to more than 1,280,000 in mid-2008, or more than 10 percent per year. A contract is for 1,000 barrels of oil, so this is a rise from 350 million barrels to more than 1.28 billion barrels. Multiplying the open interest measured in barrels by the price of oil per barrel shows that the value of the total open interest rose from $6.2 billion in mid-1995 to $180 billion in mid-2008. The other major futures contracts for crude oil are offered by the Intercontinental Exchange (ICE), which runs a copycat contract that is pegged to the NYMEX's own contract on West Texas Intermediate (WTI) crude oil. The ICE also offers its own futures contract on Brent crude, a type of oil from the North Sea and the main competitor to WTI as a benchmark for oil.[3] Combined, the open interest on these contracts is around 15 percent of the NYMEX open interest, so that the total open interest in mid-2008 was 1.441 billion barrels, or $202 billion. Table 1 and figure 1 show the combined total of open interest in futures, summed across the three contracts, from 1995 through 2008. The size is given in terms of both barrels and dollar value. A few other oil futures contracts are traded on other types of crudes and in other exchanges around the globe, but they do not increase the amount significantly.

In addition to simple futures positions, the exchanges offer options on the oil price. Where a futures contract is a pure linear bet on the price of oil, an option position is a nonlinear bet. An options position can be managed to yield a similar exposure to changes in the oil price as a futures position, and for any given open interest in option contracts, it is possible to calculate the open interest in futures required to maintain an equivalent exposure. The exposure

3. The ICE parent corporation is based in Atlanta, and a large portion of its energy trading operations are run out of Atlanta. Technically, the crude oil futures contracts are a product of the ICE's nominally London-based ICE Futures Europe subsidiary. Therefore, both of its contracts are subject to regulation by the U.K. Financial Services Authority (FSA) and not to oversight and regulation by the CFTC, despite the location of its operations and the U.S. delivery point for the oil on which the WTI contract is traded. The ICE's copycat WTI futures contract has not been subject to the same speculative position limits that the NYMEX imposes, and the FSA did not collect and disseminate the same information about the proportion of commercial and noncommercial traders. For a long time, the two regulatory authorities did not actively share information about trading and positions, which gave traders opportunities to circumvent the tighter U.S. controls. The spike in oil prices and the public debate about the role of financial speculation and lax regulation has forced both regulators and the two exchanges to revisit the ground rules and practices, although a formal revision to the system has not yet passed the U.S. Congress.

TABLE 1. Exchange-Traded Open Interest in Crude Oil

	Total futures[a]		*Plus options*[b]		*Global production*	*Global reserves*	*U.S. reserves*
Date	*Million barrels*	*Billion $*	*Million barrels*	*Billion $*	*Million barrels*	*Million barrels*	*Million barrels*
Jun 1995	398	6.8	. . .	. . .	. . .	. . .	. . .
Dec 1995	419	7.9	. . .	. . .	25,649	. . .	. . .
Jun 1996	415	8.3	. . .	. . .	. . .	. . .	. . .
Dec 1996	416	10.2	. . .	. . .	26,250	. . .	. . .
Jun 1997	466	9.1	. . .	. . .	. . .	. . .	. . .
Dec 1997	478	8.4	. . .	. . .	27,068	. . .	. . .
Jun 1998	546	7.9	. . .	. . .	. . .	. . .	. . .
Dec 1998	549	6.4	. . .	. . .	27,614	. . .	. . .
Jun 1999	653	12.5	. . .	. . .	. . .	. . .	. . .
Dec 1999	555	13.8	. . .	. . .	27,316	. . .	. . .
Jun 2000	517	16.0	724	22.5	. . .	. . .	. . .
Dec 2000	477	12.2	. . .	. . .	28,383	. . .	. . .
Jun 2001	516	13.5	. . .	. . .	. . .	. . .	. . .
Dec 2001	517	10.6	. . .	. . .	28,355	. . .	. . .
Jun 2002	530	14.1	. . .	. . .	. . .	. . .	. . .
Dec 2002	660	20.2	. . .	. . .	28,101	. . .	. . .
Jun 2003	583	17.2	. . .	. . .	. . .	. . .	. . .
Dec 2003	678	21.8	. . .	. . .	29,055	. . .	. . .
Jun 2004	761	28.1	1,163	42.9	. . .	. . .	. . .
Dec 2004	733	31.8	. . .	. . .	30,333	. . .	. . .
Jun 2005	866	49.8	. . .	. . .	. . .	. . .	. . .
Dec 2005	895	55.2	. . .	. . .	30,871	. . .	. . .
Jun 2006	1,180	88.2	. . .	. . .	. . .	. . .	. . .
Dec 2006	1,400	87.2	. . .	. . .	30,858	. . .	. . .
Jun 2007	1,669	118.5	. . .	. . .	. . .	. . .	. . .
Dec 2007	1,549	148.2	. . .	. . .	30,821	1,238,892	30,460
Jun 2008	1,441	202.5	3,068	431.2	. . .	. . .	. . .
Dec 2008	1,374	58.5	. . .	. . .	. . .	. . .	. . .

Source: Open interest figures from NYMEX and ICE via Bloomberg. Global production figures are from the U.S. Energy Information Administration. Reserves are from the BP Statistical Review of World Energy.

Notes:

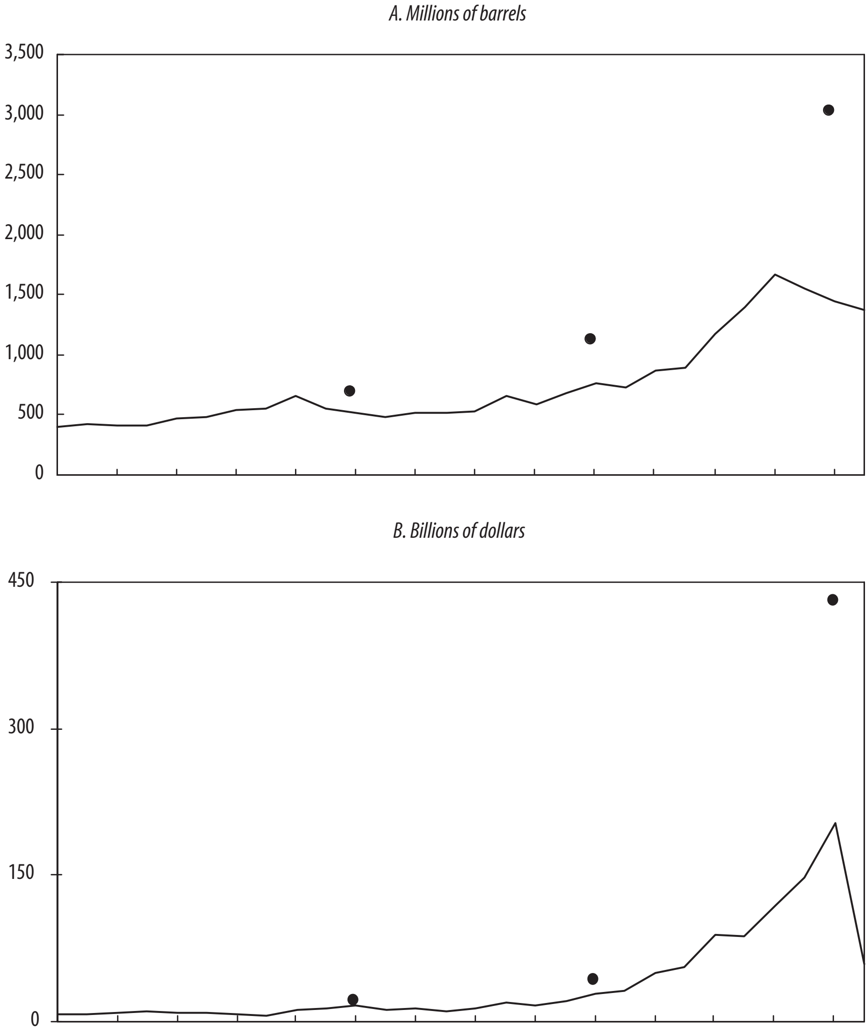
a. Futures open interest equals the sum of all contracts for the NYMEX WTI, ICE WTI, and ICE Brent crude contracts. Open interest measured in barrels is converted to dollars using the front month contract price only.

b. The calculation to include options is based on the ratios in Büyüksahin and others (2008, table 5).

created in the option markets would have added another 40 percent of open interest to the figure in 2000 and another 52 percent in 2004, and it would have more than doubled total exposure in 2008. This combined position is shown in the table and figure for select years.[4]

4. Based on Büyüksahin and others (2008, table 5).

FIGURE 1. Exchange-Traded Open Interest in Crude Oil[a]



Source: Bloomberg.

a. Open Interest is the sum of contracts for all months for the NYMEX WTI, ICE WTI, and ICE Brent crude contracts.

Off-Exchange Derivatives

Many of the financial trades on the oil price never come to the futures markets. Swap dealers can privately negotiate with customers positions that look in most regards just like futures or option contracts (or bundles of futures and option contracts). The most important difference has to do with counterparty credit risk. The other important difference is that dealers can trade tailored swaps that amount to a bundle of futures and options. It is more convenient to the customer to buy the bundle as a single package, rather than trying to trade the components themselves. Although swaps are financial instruments that create oil price exposure, this trading is not generally subject to reporting to the U.S. Commodity Futures Trading Commission (CFTC), and data on the volume and terms of the transactions are not publicly released.

Therefore, the numbers shown in table 1 and figure 1 underestimate the true size of the open interest in crude oil, since they exclude the positions that are negotiated off the exchange. The extent of the underestimation depends on the character of the swap dealer's portfolio. A swap dealer is an intermediary. It profits by enabling the trading of others. The dealer does not seek to take a position in oil on its own account. It tries to match buyers and sellers, or, through the proper management of its overall book, to match the aggregate positions of many buyers and many sellers. A swap dealer will have customers who wish to sell a futures position in oil and other customers who wish to buy a futures position in oil. Insofar as these match, that open interest is never seen by the futures exchange and so is not recorded in the numbers shown in table 1 or figure 1. The dealer will only be compelled to bring the net position to the futures exchange if it has more customers on one side or the other, thereby keeping its book hedged. The swap dealer positions that enter into the numbers shown in table 1 and figure 1 are only this residual fraction of the dealer's total book that it has brought to the exchange. Unfortunately, there is no publicly available information on the size of the dealer's book that is not brought to the exchange, so it is impossible to precisely estimate the degree to which table 1 and figure 1 underestimate the true open interest including off-exchange positions.

The Bank for International Settlements (BIS) publishes a pair of data series on the notional amounts outstanding and the gross market values of commodity derivative contracts traded over-the-counter, including oil.[5] In mid-2008, the notional amounts outstanding stood at over $13 trillion, and the market value of the positions was $2.2 trillion. Unfortunately, neither the notional amount outstanding nor the market value can be equated to open interest, so these figures cannot be compared to what is shown in table 1.

The recent public concern about speculation driving commodity prices forced the CFTC to produce its special staff report on commodity swap dealers and their positions.[6] The CFTC used its authority to issue a special call to all reporting dealers for information about their aggregate positions. Unfortunately, the CFTC chose to limit the report specifically to a subset of the dealers' activities—namely, index trading—and did not clarify how that category was defined. In doing so, it dashed hopes of developing a complete picture of dealers' off-exchange positions and a better estimate of the total size of the market. While the CFTC has the data, the public does not.

Hedgers and Speculators

Open interest reflects the positions of both nonfinancial and financial traders in oil. Many bets reflect a nonfinancial trader on one side of the contract (the hedger), with a financial trader on the other (the speculator). This is not the only possibility, however: both sides of the bet could involve financial traders or both nonfinancial traders. There is no simple way to decode from the aggregate open interest figure exactly who is doing how much of what.

The CFTC maintains a database called the large trader reporting system (LTRS), which disaggregates the positions held by participants according to various classifications. For example, it includes manufacturers, companies involved in agriculture and natural resources, and producers, all of which are natural hedgers. It also includes floor brokers/traders, futures commission merchants, introducing brokers, commodities swaps/derivatives dealers, commodity pool operators, commodity trading advisers, insurance companies, pension funds, and so on. A few of these categories clearly describe financial investors or speculators, while others are financial intermediaries that may

5. See BIS (2009, table 19). The term *over-the-counter (OTC)* is still sometimes used as a label for this activity, but its usage is troublesome. Any number of different ways of executing trades—such as the ICE copycat WTI contract—have been developed to work around the old regulatory structure using different legal strategems, including exempt commercial markets and other loopholes. The term *OTC* has come to signify any trading outside the regulated exchanges, regardless of the institutional framework for the trading.

6. See CFTC (2008).

serve both financial and nonfinancial clients, and still others may clearly be agents of purely financial investors.

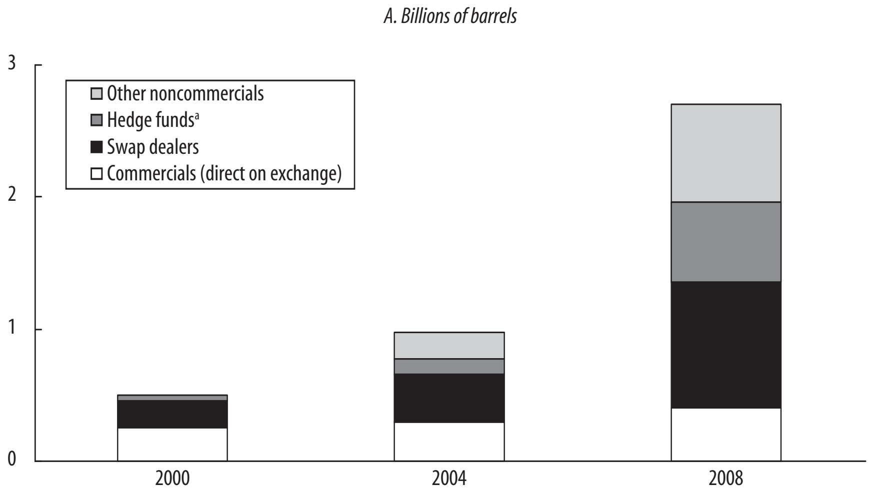
The CFTC does not publicly report information at this level of detail, however. Instead, it publishes a regular Commitments of Traders (COT) report, which aggregates these various categories into two classes: commercial and noncommercial. Originally, this classification roughly corresponded to the natural distinction between financial and nonfinancial participants, or speculators and hedgers. Over time, the CFTC, under political pressures exerted through various channels, has allowed the meaning of the two categories to break down, so that the report is now markedly less informative. The major fault arises because swap dealers, who often stand merely as an intermediary to a speculator, became exempted from position limits imposed on speculators and were reclassified for reporting purposes as hedgers or "commercials."[7] Seen from the narrow perspective of the swap dealers' own books of orders, the dealers are indeed hedging: on the one side, they have the position of their ultimate customer, so they come to the futures market to hedge that by purchasing an offsetting position. Seen from the perspective of their role in the marketplace, however, the positions they are bringing to the exchange are speculations. This blurring of categories has made the regular COT report relatively uninformative precisely when financial investment in oil has been exploding.

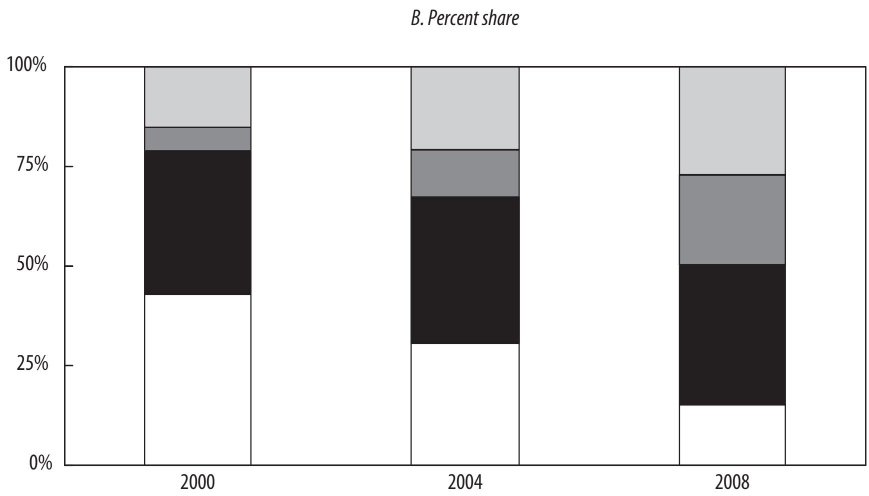
The CFTC sanctioned a small number of academic studies that report some salient statistics from the disaggregated categories of the LTRS, and these studies provide some insight into the share of the open interest represented by the different financial players. Figure 2 shows the share of the total open interest accounted for by four categories of traders at three points in time (2000, 2004, and 2008). I have aggregated the various commercials into a single category, and I show three categories that may be thought of as noncommercials: swap dealer, hedge funds, and other noncommercials.[8] For commercials, the average open interest (futures plus futures-equivalent options) increased 63 percent over the eight years, while for noncommercials it increased by nearly 600 percent. This means that the noncommercial category grew from

7. CFTC (2008) provides a brief legislative history of this change. The issue has effectively been reopened, and the CFTC has announced a "Concept Release on Whether to Eliminate the Bona Fide Hedge Exemption for Certain Swap Dealers and Create a New Limited Risk Management Exemption from Speculative Position Limits" (24 March 2009).

8. Following the original source (Büyüksahin and others, 2008), I use the category label *hedge funds*, which is an aggregation of several CFTC categories that are known to represent the trades of well-known hedge funds.

FIGURE 2. Shares of Open Interest on All Contracts, by Type of Trader





Source: Based on Büyüksahin and others (2008, table 5).

a. The hedge fund category aggregates several finer categories in the CFTC LTRS database; see original source for breakdown.

just over 50 percent of the total open interest to 85 percent in 2008.[9] In 2008, swap dealers represented 35 percent of the total open interest, while hedge funds represented 23 percent. Other noncommercial participants grew from only 6 percent of open interest to 16 percent.

Later I focus on the long-maturity contracts, so it is interesting to look at the participation shares out at the long end of the curve. For this calculation, the long end is defined as contracts maturing in three or more years. In the case of commercials, the average open interest in these long maturities increased 72 percent over the eight years, while for noncommercials it increased by more than 1,200 percent, double the rate of growth in all maturities taken together. The noncommercial category grew from just over 50 percent of the total open interest to more than 90 percent in 2008. In 2008, swap dealers represented 59 percent of the total open interest, while hedge funds represented 24 percent. While the size of the market at these long maturities is small (approximately 6 percent of total open interest) the growth in the market over these years has meant that the total open interest in these contracts in 2008 was approximately equal to the total open interest in the shortest contracts (0–3 months) in 2000.

Index Funds

Index funds, or index trading, are a major class of financial investment in commodities. Index trading is an extension of traditional portfolio management. An important concept in portfolio management is wide diversification of investments across a broad spectrum of assets, maximizing the combined return while minimizing the risk through diversification. An investment in commodity futures is just one more so-called asset class, like government bonds, corporate bonds, large stocks, and small stocks.

The idea of adding commodity futures contracts to a well-diversified portfolio has been around a long time.[10] However, a variety of evolutionary changes in various institutions made it a realistic option for a large number of investors holding a large pot of investment dollars. A major turning point came with the creation of the Goldman Sachs Commodity Index (GSCI) in 1991. The GSCI, which has since been sold to Standard and Poor's, invests

9. I have aggregated the three categories of swap dealer, hedge fund, and other noncommercial into a subtotal for noncommercial. Figure 2 shows the breakdown into the three elements. Some of the swap dealer's business may also represent trades by commercials, so this may overestimate the share of noncommercial trades.

10. See, for example, Greer (1978) and Bodie and Rosansky (1980).

in an array of different commodity futures spanning energy, industrial and precious metals, and agricultural and livestock. Because the energy futures markets are among the deepest and most liquid financial commodity markets in the world, the index has always been heavily weighted toward energy (now more than 67 percent), specifically crude oil (now 48 percent). Customers can buy into the index much as they would buy into a mutual fund. Several similar competing indexes have been created, although the major alternative in recent years has been the Dow Jones-AIG Commodity Index (DJ-AIGCI).

Index trading may be a form of passive investing, in which the investor takes no view of whether the commodity price is too high or too low, but merely seeks to hold exposure bought at the market rate. As with all vehicles for passive investing, many investors bend the concept by changing the chosen weights on different commodities according to where they think a higher or lower return is likely to be coming over the near term. Other investors may use the channel created by the index to take an active bet on various commodities. Each dealer offers a variety of incarnations of its commodity index, just as mutual fund companies offer a range of different fund types, and dealers compete by structuring their indexes with different weights and so forth. The dealers market their particular strategies.

When the popular press reports the volume of money currently invested in commodities, they are usually reporting on index money. Indeed, the reports often specifically conjecture on the amount of money in the GSCI, in the DJ-AIGCI, and in funds that attempt to mimic these two funds. These reports are conjecture benchmarked against disparate tidbits of public data. There is no authoritative source that tallies the aggregate of funds invested in index trades. The most recently popular benchmark derives from the CFTC's decision in 2006 to start producing a supplement to its COT report that purports to specifically identify index trades by swap dealers in a select set of agricultural commodities. With these data in hand, and using the known index weighting used in the standard GSCI and DJ-AIGCI, it is possible to back out an estimate of the index dollars invested in all of the other commodities. The methodology is described by Masters and White, who use it to estimate a January 2006 position for the GSCI of more than $47 billion and for the DJ-AIGCI of more than $27 billion.[11] Of this, the method suggests that the GSCI held more than $21 billion in crude oil, with the DJ-AIGCI at more than $3 billion. Combined, this represents 43 percent of the open interest on the combined crude contracts trading on the NYMEX and ICE at the time.

11. Masters and White (2008).

Press estimates for mid-2008 put the total index commodities investment at $400 billion.[12] Assuming the same fraction of index money invested in crude oil, this would imply approximately $130 billion, or 64 percent of the combined crude open interest on the NYMEX and ICE. Masters and White estimate over 880 million barrels of crude in indexes, or more than $120 billion.[13]

In its staff report on commodity swap dealers and their positions, the CFTC purports to have calculated the total index trades held by swap dealers at three dates: 31 December 2007, 31 March 2008, and 30 June 2008.[14] Its estimates are markedly lower than those circulating in widely cited press reports. For example, the report estimates the total commodity index exposure at $200 billion and the exposure to NYMEX crude oil at $51 billion. The CTFC does not explain the methodology used to determine what to include as an index trade. The report claims to encompass both on- and off-exchange exposures, so one might have expected the figure to be larger than other calculations based exclusively on exchange positions. Instead, the CFTC number is markedly smaller. The CFTC's report does not benchmark its result to any of these widely circulated numbers based on well-documented methodologies and public data, so the reason for the discrepancy remains a puzzle.

Indexes are only one type of product that dealers offer, and other financial investors—such as hedge funds—can create their own customized version of an index. Without an authoritative public data source, this element of the oil market cannot be accurately described. Analysts have only a minimal sense of how large it is and a clear sense that it has grown significantly over time. In addition, index funds' own reports of their methodology, combined with the earlier data reported, suggest that index trading has gradually moved its exposure out to the longer end of the forward curve.

In Comparison with the Physical Oil Market

In 2007 the global production of crude oil was approximately 30.8 billion barrels.[15] The total open interest on the NYMEX and ICE was approximately 1.5 billion barrels, or 5 percent of total annual production. For comparison purposes, table 1 presents the total flow of oil during the calendar year and

12. Stewart Bailey, "'Tidal Wave' in Commodities Rises to $400 Billion," Bloomberg, 7 April 2008. Available online at www.bloomberg.com/apps/news?pid=newsarchive&sid=a8KQlVrvchkw.

13. Masters and White (2008).

14. CFTC (2008).

15. U.S. Energy Information Administration (www.eia.doe.gov/emeu/international/oilproduction.html).

the total stock of bets on oil in place at the end of the year. The table shows that total open interest as a share of total production was fairly stable at around 2 percent until it began to climb in 2002.

Some of those who argue that financial investments drove the oil price spike talk as if the flow of money into futures was somehow actually in competition with physical demand for the flow of production. Masters and White, for example, compare the flow of money into oil with the increased consumption of oil in China.[16] However, financial investors do not consume oil, and they do not in any direct way divert production away from delivery to satisfy demand. This obvious error annoys the inner pedant of many economists, and it takes the focus away from other channels by which this flow of funds might be affecting price. Some of these other channels are also mentioned in Masters and White, among other popular sources.[17]

While the flow of funds into oil futures and related financial investments is not in competition with demand for actual oil consumption, it is a form of ownership of oil. It is analogous to a flow of passive equity capital into other assets: equity in the sense of taking on the exposure to price movements; passive in the sense that the assumed exposure is exogenous and there is no direct management of the underlying asset. It would be analogous to a flow of funds buying up rental housing or sharing an equity stake in owner-occupied housing. The financial owner isn't seeking to evict anyone and hold the house empty and unused. The price of housing will not rise because of competition with renters for scarce homes. Can the price of housing, however, be driven up by this new flow of equity capital into the market? Can the price of oil and oil-linked assets be driven up, in part, by this new flow of equity capital into oil?

Restating the question this way suggests that the flow of financial investments in oil should be compared not to the annual production of oil, but to the asset base of oil. This is hard to do for a number of reasons, so I oversimplify to arrive at an initial calculation. In 2007 the global proved reserves of crude oil totaled approximately 1.2 trillion barrels.[18] The total open interest on the NYMEX and ICE was approximately 1.5 billion barrels, or slightly more than one-tenth of 1 percent of total proved reserves. Including options probably doubles this fraction. Of course, the vast majority of these reserves are controlled by nation-states or their national oil companies, and the assets are

16. Masters and White (2008).

17. Masters and White (2008).

18. U.S. Energy Information Administration (www.eia.doe.gov/emeu/international/oilreserves.html), citing the *BP Statistical Review of World Energy,* June 2008.

not available for trade. Total U.S. reserves were just over 30 billion barrels, so the total open interest equals just over 5 percent of reserves—just over 10 percent if options are included. These figures are included in table 1 for convenience. The 10 percent ratio represents the total accumulation as of year-end 2007, but half of this was accumulated over the period 2004–07. The issue for analysis, then, becomes what would happen if a new flow of capital suddenly purchased an equity stake in 5 percent of the oil assets. Would that asset demand (as opposed to consumption demand) in that window of time move the asset price?[19]

Masters and White argue that order flow in an asset market drives price.[20] That is one possible channel through which this could happen, but they rhetorically exaggerate the size and duration of order flow in asset markets, and they never attempt to take the theory to the data relevant for the oil market. They quickly revert to comparing financial flows to consumption, which is the wrong approach. On its own, I doubt that a flow of that size could have much of an impact on an asset base of that size.[21] Something more would have to occur for this financial flow to matter very significantly. I return to this later.

Oil Price Dynamics

A sound discussion of the returns to an investment in oil futures requires a digression into the stochastic dynamics of oil prices and some detail on the term structure of futures prices. An important new dynamic that arose during the oil price spike of 2003–08 is reflected only in an analysis of the full term structure. Discussions that concentrate exclusively on movements in the spot price miss this key historical fact. This new dynamic is important to how

19. Proved reserves are a widely misunderstood concept, among economists as well as the broader populace. Proved reserves are not comparable to the well-defined stock of a nonrenewable resource at the heart of Hotelling's famous rule (Hotelling, 1931), but are more analogous to an inventory of manufactured goods (Adelman, 1993). The production process involves investment in exploration and other drilling, and the returns to the investment arrive stochastically, as with a Poisson process. Also, the practice of determining and declaring proved reserves varies widely across countries, so that the data from many countries are a managed figure tied less to underlying facts of geology and economics than to politics.

20. Masters and White (2008).

21. The CFTC, together with other agencies, did make some effort to address the order flow question: see the Interagency Task Force on Commodity Markets (2008), which summarizes the results documented in Büyüksahin and others (2008). They are skeptical that order flow played a significant role.

investor beliefs evolved during this time, and it is relevant to how a bubble might have grown.

Modeling Oil Price Dynamics

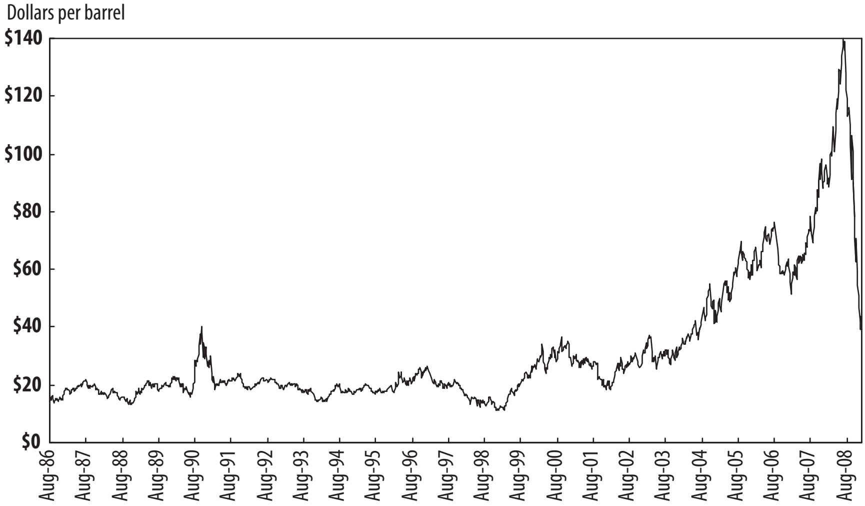
The evolution of the oil price is determined by a host of factors. On the supply side, there are developments in technology that open up the possibility of drilling in previously inaccessible locations, movements in various factor prices, and the stochastic realization of new resource discoveries. On the demand side, there is the growth of global population and general economic level of development, the changing suite of technologies for fueling transportation, and so on. Many political factors are also at work on both the supply and the demand side. For the purpose of this paper, it is convenient to collapse all these many factors and complicated dynamics into an oversimplified taxonomy that distinguishes just two sets of factors. The first set comprises short-term, transitory shocks to either supply or demand. The second set causes a permanent shift in expectations of the long-term equilibrium price. I speak in reduced form as if the price is directly moved either by a short-term, transitory factor or by a long-term, permanent factor, without expounding on the process of equilibration between the supply curve and the demand curve.

Just such a two-factor model was originally developed by Gibson and Schwartz and then reinterpreted by Baker, Mayfield, and Parsons and Schwartz and Smith, with the two factors represented as a short-term, transient factor and a long-term, lasting factor.[22] Each factor is subject to random shocks. Shocks to the short-term factor do not have a lasting effect on the price of oil at long horizons, but effects dissipate gradually. In contrast, shocks to the long-term factor are lasting and thus cumulative.

Despite the oversimplification involved, this two-factor model of the oil price is a convenient tool for narrating at least some of the dynamics observed in the actual history of the spot price of oil. Figure 3 graphs the oil price from 1986 to 2008. In the period before 2003, the price occasionally swings up or down, but it then reverses back toward its central tendency. These swings are a reflection of short-term, transitory disturbances to either supply or demand (or both). Before the recent run-up in the oil price, the most dramatic swing was the sharp price spike occasioned by the first Gulf War in late 1990. Starting from a level below $18 per barrel in mid-July, the price peaked above

22. Gibson and Schwartz (1990); Schwartz (1997); Baker, Mayfield, and Parsons (1998); Schwartz and Smith (2000).

FIGURE 3. Oil Price, 1986–2008[a]



Source: Bloomberg.
a. The series shown is the front-month WTI futures price, weekly from July 1986 through December 2008.

$40 per barrel in October, then fell back below $18 per barrel by late February 1991. A less dramatic drop in prices occurred in 1993, when conflicts within OPEC resulted in a temporary glut of supplies and prices went from over $18 per barrel in August to below $14 per barrel in December, recovering back to over $18 per barrel again in June 1994. This temporary drop in the spot price occasioned the brush with bankruptcy by the German company Metallgesellschaft, as a result of its speculation in oil futures.

Distinct from these short-run, transitory price swings are the movements that seem likely to reflect shifts in longer-term fundamentals and thus may have a lasting impact on price. In the two-factor model, these longer-term shifts are represented as a random walk. Each innovation shifts the forecasted price at all horizons. Innovations may compound, leading to a persistent rise or fall in the price, or innovations may cancel one another out. The key is that the compound result is not predictable, whereas for the transitory swings the reversal is predictable.

From December 1998 to November 2000, the price nearly tripled from $11 per barrel to $35 per barrel. This dramatic increase was marked by several reversals of around $10 per barrel before the upward trend recovered. Then, within the space of slightly more than a year, the price fell again to

$18 per barrel and recovered as quickly to above $30, continuing its rise marked by swings of as much as $10 per barrel. For all of these swings, the recovery occurs within less than a year, sometimes within a couple of months. During the price run-up of 2003 through mid-2008, the series still exhibits some striking swings around the realized trend, such as the drop in price in late 2006.

The largest apparent swing in the price is clearly the spike in mid-2008. In this case, reading the data in terms of the two-factor model is more difficult, albeit not impossible. The swing is too large to be attributed completely to short-run, transitory shocks whose dissipation should have been anticipated. Instead, believers that the spike was caused by fundamental movements in supply and demand are forced to explain this as one of those peculiar sample paths that arise in any random walk: at least a good portion of the price run-up was expected to persist, and it might have done so had there not been a global financial collapse and resulting economic recession. The drop, or at least a major portion of it, was unanticipated and reflects an unusually large shock to the long-term factor.

In this two-factor model, the observed volatility of the spot price is a function of the volatilities of both factors. Typical estimates put the total raw annualized weekly volatility of returns on the spot oil price in the neighborhood of 30–35 percent, with approximately one-half of that volatility coming from short-term, transitory shocks that dissipate, leaving the long-term factor with a volatility of close to 14–16 percent.[23]

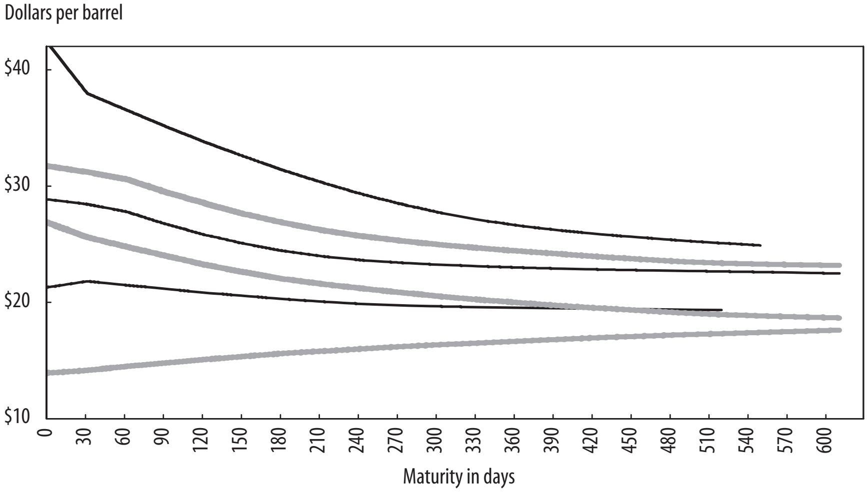
The Term Structure of Futures Prices

Figure 4 displays the graphs of the term structure of futures prices prevailing at several different dates. The horizontal axis shows the time to maturity for the futures contracts whose prices are graphed. Each solid line reflects the full term structure prevailing on a single date. The points on one line correspond to the prices of contracts maturing at different horizons in the future. Moving from line to line shows how the term structure has moved between dates.

The range of prices at short maturities is much larger than the range of prices at long maturities. If spot prices evolve according to the two-factor model described above, the volatility of short-maturity contracts will be higher than the volatility of long-maturity contracts. Volatility in short-term elements of supply and demand will have a large impact on short-maturity con-

23. See Schwartz and Smith (2000); Herce, Parsons, and Ready (2006).

FIGURE 4. The Term Structure of Oil Futures on Selected Dates

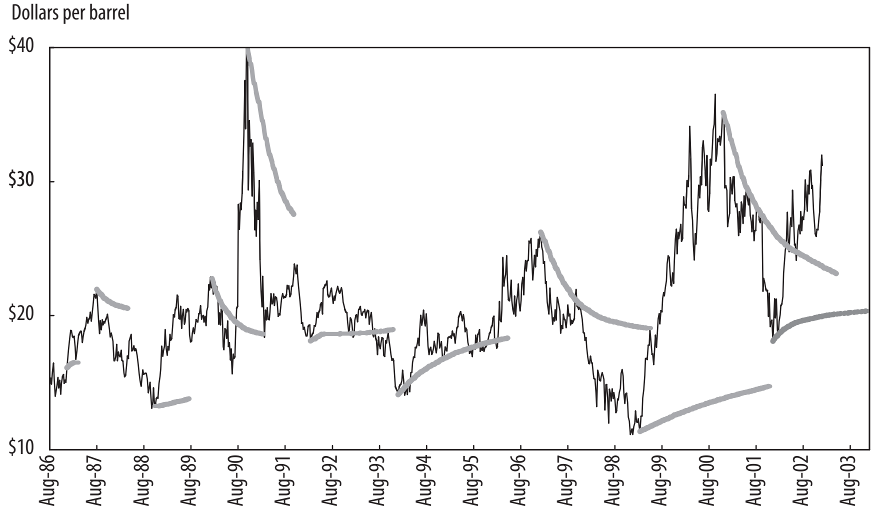


Source: Bloomberg.

tracts, but only a small impact on long-maturity contracts. This is because the short-term factors are transitory. There is time for the system to adjust back to the equilibrium level governed by the long-term factor. The impact of a shock to the short-term factor on a long-term futures price should decrease asymptotically to zero as the maturity of the contract goes to infinity. If the long-term factor is allowed to evolve, there will be volatility in long-term futures contracts, too, but volatility in the long-term factor affects both short- and long-maturity contracts equally. Hence, volatility in short-maturity contracts is the product of volatility in both the short-term and the long-term factors, while volatility in the long-maturity contracts is the product solely of volatility in the long-term factor. Short-maturity contracts are more volatile.

Figure 4 can also help clarify some classic terminology employed in the futures market. The top curve in the figure displays the shape known as backwardation: the price is declining with maturity. The bottom curve displays the shape known as contango: the price is rising with maturity. The oil price curve is sometimes in backwardation and sometimes in contango. One factor determining whether it is in backwardation or contango is the current realization of shocks to the short-term factor. When supplies have been temporarily disrupted and the spot price has risen, the spot price is expected to decline again, reverting to the long-term level. If there is a temporary glut of supply

FIGURE 5. Selected Futures Term Structures, 1986–2002



Source: Bloomberg.

on the market, then the spot price will clear at a temporarily low level, and expectations will be that it will rise again to the long-term level. These expectations about the future spot price at date $t + \tau$ are translated to the current futures price (at date t) for a contract maturing τ periods forward.

Figure 5 clearly shows this expectation component of the term structure of futures prices. The figure shows the time series of the spot price during just the early part of the analysis, 1986–2002. Overlaid on top are the futures price term structures at eleven selected dates. Each term structure is placed so that the price of a futures contract of a given maturity is aligned with the actual date of maturity. For example, during the first Gulf War, the spot price on 9 October 1990 was near its peak at just over $40.00 a barrel, the price for a futures contract for delivery three months later was $35.80, and the price for a futures contract maturing fifteen months later was $26.03. The declining term structure clearly reflected market expectations that the Gulf War would not disrupt supply for too long and that spot prices would come back down again. In December 1993, when spot prices had fallen to $14.67, the price for a three-month futures contract was $15.51 and the price for a fifteen-month contract was $17.49. This likely reflects market expectations that the glut of supply in December would not last and the spot price would climb back up. For 1993–2002, the figure shows five futures term structures. During this period, the price rose and fell sharply below and sharply above $20.00 a barrel. The five term structures charted at the various peaks and troughs of this movement show that the market was forecasting that the price would return back to a more central number, perhaps somewhere in the neighborhood of $20.00 a barrel.

Although oil futures fluctuate between backwardation and contango, on average they have been backwardated: more often than not, the front end contract has been the most expensive contract, and the term structure of futures prices at a given point in time has declined with maturity, at least near the front end of the curve. This is not surprising. The two-factor theoretical model described above is consistent with a curve that is either more often in backwardation or more often in contango, depending on whether the equilibrium risk premium associated with the short-term factor is positive or negative.[24] This equilibrium risk-premium reflects equilibrium in the underlying operation of storage for the commodity, as well as how capital markets price this risk and other portfolio risks. As it happens, the cost of storing oil above ground is very high, and, at least historically, the short-term factor has paid a positive risk premium—that is, the term structure of oil prices is usually backwardated. For many other commodities, the term structure is more often in contango. Oil is unusual in this regard.

The Strategy and Returns to Investment in Oil Futures

How does ownership of oil futures contribute to an investment portfolio? In the section below, I describe the two different sources of return. One source is related to the shape of the term structure, while the other is related to the oil price level. I then show that the first source of return dominated in the early period of 1985–2002, while the second source of return dominated in 2003–08. The string of profits earned from rising oil prices in this second period played an important role. As experience in other asset markets shows, investors often draw strong, unfounded conclusions from a short history of returns, and the dynamics of these beliefs can be a contributing factor to an asset bubble.

24. The risk premium on the long-term factor, together with the expected drift of the commodity price, determines whether the curve is rising or falling out at the long end of the term structure. Thus, even if the term structure is falling at the front end, it can be rising at the long end. Historically, the slope at the long end has fluctuated tremendously.

The Returns to an Investment in Oil Futures

The model assumes that oil price dynamics are governed by two factors. Therefore, an investment in oil futures will capture two distinct sources of return: the short-term risk premium and the long-term risk premium. Different portfolios of futures contain different amounts of the two risks, so they capture different mixtures of the two returns. Financial engineering or risk management is all about being able to craft any combination of returns desired.

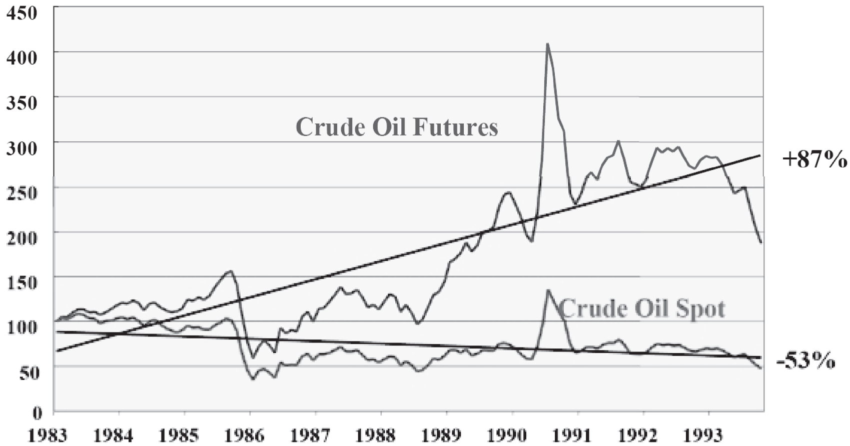
For example, a simple long position in the one-month futures contract will contain both the short-term and the long-term risk in approximately equal measure (based on estimates previously cited). A long position in the two-month futures contract will have the same amount of the long-term risk, but a smaller amount of the short-term risk. Constructing a short position in one contract and a long position in another contract produces a linear combination of the two risk factors, and since contracts with different maturities contain different amounts of the two risk factors, it is possible to structure this short-long portfolio so as to own exclusively one factor or the other.[25] Whatever portfolio of the two factors of risk is chosen, this will then be blended into a larger investment portfolio where risks and returns will be combined according to the Markowitz portfolio theory.

Marketed index funds are long investments in futures, and all of the original articles that advocated adding commodities to an investment portfolio were written at a time when only short-maturity contracts were available. Hence, the portfolio usually involves long positions in short maturities and includes returns associated with both the short- and the long-term factor. Figure 6 illustrates why this is important.[26] The figure shows the spot crude oil price from 1983 to 1993, which had ups and downs, but overall declined by 53 percent. The figure also shows the returns earned on a long portfolio of crude oil futures in the same period. Although the spot price fell, a long port-

25. The German industrial company Metallgesellschaft nearly went bankrupt when a subsidiary got it wrong. It was short a set of long-maturity physical supply contracts and therefore had a negative exposure primarily to the long-term factor. It tried to hedge this by buying short-maturity futures contracts. This successfully hedged its exposure to the long-term factor, but added a new exposure to the short-term factor. When the short-term factor moved, this exposure was its undoing (see Mello and Parsons, 1995). Neuberger (1999) shows how the hedge might have been done correctly.

26. The figure is based on a classic paper advertising the benefits of investing in commodity futures authored by Wharton and Yale professors Gary Gorton and Geert Rouwenhorst, who teamed with AIG on its development of a commodity investment vehicle (Gorton and Rouwenhorst, 2006). The figure doesn't appear in the paper, but is taken from a presentation by Rouwenhorst.

FIGURE 6. Returns to a Portfolio of Futures versus the Level of the Spot Price



Source: Gorton and Rouwenhorst (2006). Figure is taken from a related presentation by Rouwenhorst.

folio of futures earned a positive return. This demonstrates that an investment in futures is not necessarily the same thing as a bet that spot prices will climb. The ten-year change in the spot price reflects the realization of the long-term factor, which over this window of time happened to fall. But a long position in short-maturity oil futures captures two returns in roughly equal measure: the return on the long-term factor and the return on the short-term factor. Although the long-term factor earned a negative return in this period, the realized returns on the short-term factor more than compensated for the loss. As noted earlier, the risk premium on the short-term factor has generally been positive, and a portfolio that was long the short-term factor has generally, but not always, earned a positive return.

The fact that either factor may earn a positive or negative return is not dispositive of whether it should be added to an investment portfolio. The key to that decision is its contribution to diversification together with its own return. This, in turn, depends on the correlation with other securities in the portfolio. Many commodities have a modestly negative expected return on the short-term factor—due to the contango—and are nevertheless included in the portfolio in small amounts because the diversification benefits are thought to be high. However, many investors do not carefully consider the full portfolio optimization model and simply chase high realized returns—and many portfolio managers and financial institutions know how to market to that instinct.

In this connection, there are two things to note about the period prior to 2003, when the new investment vehicles for commodity futures were first being successfully developed and an initial population of investors was learning how to participate in this market. First, most commodities were limited to futures contracts with very short maturities. Even those, like oil, that offered contracts out many months had very little liquidity in those longer maturities.[27] The original indexes were marketed using relatively rigid formulas for their investment strategy, and they thus limited themselves to the shortest, most liquid contracts. Moreover, because of the historic backwardation in the oil futures curve, the shortest-maturity contracts had always exhibited the greatest return. This was a critical fact for marketing the indexes. Second, from 1986 onward, the level of the spot oil price did not trend markedly one way or the other. Therefore, during this long window of time, virtually none of the realized return on a long position in oil futures came from increases in the spot price—that is, none was due to the long-term factor. Instead, virtually all of the realized return was due to the short-term factor.

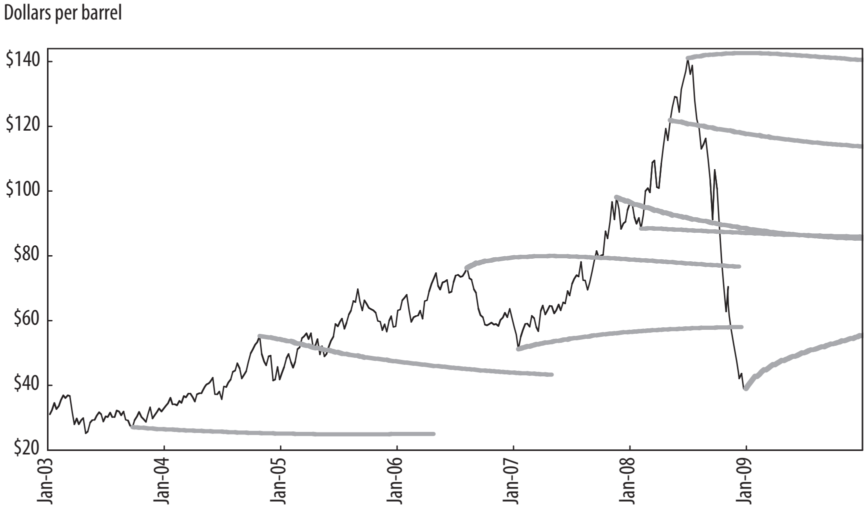
The Changing Expectations Dynamic

Everything flipped around as the price of oil began to rise in 2003. First, the continually rising spot price became a very important and consistent contributor to the return on a portfolio of oil futures. Second, late in 2004 the term structure for oil switched into a deep, long-lasting contango, causing the portfolio to lose money on the short-term factor. These two conditions created a strikingly different dynamic within the financial industry that was selling commodity investments. In the earlier period, being long the short-term factor was the key to turning a large profit, but now, being long the long-term factor became the key. Previously, being long a short-maturity contract and short a long-maturity contract was the way to maximize return, whereas later the trick was to avoid the short-maturity contracts and be long the long-maturity contracts. As documented above, liquidity moved out into the longer-maturity contracts, driven primarily by activity from financial investors.

One other thing was markedly different about the period when the price was rising. Figure 7 is a companion to figure 5. It shows the time series of the spot price from 2003–08. Overlaid on this are the futures term structures at

27. Prior to 1989, oil futures contracts did not extend beyond one year, and liquidity in these longer maturities was virtually nonexistent. The NYMEX gradually extended the horizon of available maturities, offering contracts out to three years by 1994 and then up to seven years by 1999.

FIGURE 7. Selected Futures Term Structures, 2003–08



Source: Bloomberg.

nine selected dates. In figure 5, the futures prices regularly point down or up according to whether the spot price is in a temporary peak or trough. In figure 7, however, as the spot price moves up, even long-dated futures prices move with it. The same thing generally happens on the way down.[28] Throughout this period, innovations in the oil price are innovations at the long end of the curve, innovations in the long-term factor. The futures curve is moving up and down in a more or less parallel fashion. It is being driven by changes in the long end of the curve. Volatility at the long end rises dramatically, whereas volatility at the short end stays relatively constant. The volatility on the front-month futures contract is 39 percent in 1995–2002 and 40 percent in 2003–08. In contrast, the volatility on a two-year futures contract rises from approximately 15 percent in 1995–2002 to more than 25 percent in 2003–08. The contribution of the short-term factor and the long-term factor to total spot price volatility is reversed: in 1995–2002, the short-term factor was responsible for 64 percent of total volatility and the long-term factor 36 percent; in 2003–08, the short-term factor was only

28. The December 2008 bottom does show a rising futures curve, suggesting that investors may have understood that the very low spot price was potentially a temporary phenomenon related, at least in part, to the financial crisis and global recession.

responsible for 37 percent of total volatility, with the long-term factor accounting for the remaining 63 percent.

This changed dynamic at the long end of the futures term structure is important for addressing the issue of the missing stockpiles of oil. As usually posed, the argument about stockpiles oversimplifies both the physical oil market and the paper oil market. The focus on above-ground stockpiles forgets that in the oil business, the above-ground storage decision is a very short horizon problem. Oil is very expensive to store above ground, and only a very low level of inventory is maintained at any given time. The return to above-ground storage is determined primarily by factors related to the short-run volatility in the spot price, together with the slope of the forward curve at short maturities. If the entire term structure is shifted up in parallel fashion, so that the difference between the first-month contract price and the second-month contract price stays constant, then the calculus regarding above-ground storage is unaffected. So long as investors believe that the long-term price of oil is high, it makes no sense for them to change their short-run production decisions to pump an extra barrel of oil for the purpose of storing the extra unit in tanks until the time of sale. An elevated level of the entire term structure should not produce a growing stockpile of oil stored in above-ground tanks.

If the level of the entire term structure is too high—that is, if there is a bubble—it will certainly distort real investment and production decisions in the oil industry, leading to a greater and greater disconnect between the inflated price and the realized returns. That is the nature of a speculative bubble. Sooner or later the disconnect between the inflated price and fundamentals will become apparent: the bubble will burst. In the new world of oil, however, the disconnect will not immediately be evidenced in the form of above-ground stockpiles of oil. The false price signal from the high level of the futures curve will steer excess investment into developing new resources and production capacity, but these are not as simply tallied as above-ground storage. Some analysts have tried to retreat from pressing the case about above-ground storage and sought instead to consider underground stocks. Unfortunately, the data there are abysmal. Only a few countries have standard-setting bodies that seriously enforce a meaningfully consistent definition of reserves. The vast majority of global reserves are controlled by nation-states that exercise political discretion on the public reporting of their reserves. Additionally, the actual economic process of developing true reserves is extremely stochastic, which creates significant problems for identifying the accumulation of excess reserves over such a short window of time.

Consequently, there will be no agreement that the investment flows and anticipated capacity are too large, at least for a while. Indeed, this is one key factor that makes oil a candidate for a speculative bubble. If it were easy to specify an obvious benchmark against which to measure the price, then beliefs about the price could not so easily fly free. The gradually inflating bubble affects longer-term decisions, and it is only in the playing out of the longer-term decisions that the reality of the bubble becomes apparent.

To summarize, four key events came together in 2003–08 to contribute to the oil price bubble. First, oil futures became available at longer and longer maturities; at these maturities the purchase of futures became a bet solely on the direction of the spot price, without any of the return from backwardation and, therefore, without any direct connection to short-term storage decisions. Second, the market switched into a deep, long-lasting contango that compromised the return on the traditional index portfolio strategy of being long the short-maturity contracts, driving index investors out to longer maturities. Third, the oil price level began to rise, with the term structure moving up persistently at all maturities, so that the major returns on a futures portfolio came from the rising spot price. Finally, investment vehicles for commodities had been growing, as the large profits from the rise in the price level fueled a rapidly growing stream of funds in search of these profits. The price level rise continued in a lasting fashion, validating the initial investments and encouraging additional ones.

This dynamic in the paper oil market cannot be seen independently of what was going on elsewhere in the economy.[29] From a financial point of view, the oil market may have been a sideshow or a symptom of the larger euphoria, even though the consequences for things like gasoline prices were prominent in the popular media.

Conclusions

The debate about the causes of the oil price spike have prompted calls for changing policies regarding speculative activity in the oil markets. Under consideration are two types of reforms. The first type addresses who is allowed to trade and how much. These are provisions to restrict speculation.

29. Caballero, Farhi, and Gourinchas (2008) argue that the financial collapse in other markets in 2007 sent investors in search of an alternative asset—and they found it, at least in part, in oil. Their argument, therefore, focuses on only the final, most spectacular rise in the price of oil, as being caused by this flow of financial capital.

The second type of reform calls for transparency in the marketplace, bringing all transactions into the light and under the purview of regulators.

The long-standing practice in U.S. commodity futures markets gave regulatory authorities the right to impose position limits—that is, restrictions on the size of any individual party's position in the marketplace. These limits were differentiated, with bona fide hedgers oftentimes exempted. The intention of the law was to enforce the limits against all nonhedgers, including all financial players. Unfortunately, with the rise of the OTC swap market and the extension of this exemption to swap dealers, the traditional power of this regulation was undermined. Restoring position limits on all nonhedgers, including swap dealers, is a useful reform that gives regulators the powers necessary to ensure the integrity of the market.

Although this reform is useful, it will not prevent another speculative bubble in oil. The general purpose of speculative limits is to constrain manipulation, as well as to limit the sudden rise of order flows that would disrupt an orderly market. These are smaller and shorter-lived problems quite unlike an asset bubble driven by the type of widespread and gradually evolving beliefs that may have been at work in the 2003–08 oil price. Position limits, while useful, will not be useful against an asset bubble. That is really more of a macroeconomic problem, and it is not readily managed with microeconomic levers at the individual exchange level.

Perhaps for this reason, some would like to carry the restriction further and simply ban all speculative activity in the oil futures market. Speculation should not be banned, however, just because an asset bubble is a bad thing that is driven by speculative activity and investor beliefs. It is not a bad thing that oil became a financial asset. Rather, it facilitates many types of real investment and thus lowers the cost of production. The possibility of an asset bubble is an unfortunate liability that comes with the territory. The market should learn to be cautious about the possibility, and the polity needs to be ready to take measures to avoid the development of bubbles, but stopping speculation would not be a useful step along the way.

It would be useful to bring the paper oil market back into the open and subject to the supervision of the CFTC. The lack of transparency is a dangerous thing, for all the reasons that the financial crisis put into bold relief. The oil and other energy markets have been far too opaque over the last two decades, and there have been bad actors lurking in the shadows. It would be wise to fix this. Moreover, it is a terribly, terribly easy step to take. Transparency is necessary to making the market function more effectively as a real market. It is a good that everyone but a few special interests ought to agree on.

At the same time, the opacity of the paper oil markets had little to do with the oil price spike. If the lack of transparency made any contribution to a bubble in the oil price, it was probably marginal. These two issues, too, are mostly orthogonal. Whether the lack of transparency contributed to the bubble or not, there is no good reason for it.

The idea of an asset bubble is sometimes confused with the notion that financial investors are somehow manipulating the price. The two need not coincide. The beliefs driving a bubble can gain traction without there being any identifiable individuals behind it. There is no evidence of manipulation on any scale corresponding to the size of the oil price spike. Individual actors have sought to manipulate expectations and mask their activity—the most recent and relevant example being the company Vitol—but there are always cases of manipulation and masking in futures markets. They should be prosecuted, and an assessment should be made to ensure that the CFTC has sufficient resources for performing its task in this regard. Nevertheless, the issue of active manipulation is orthogonal to the question of an oil price bubble, at least during the 2003–08 period.

The oil price spike of 2003–08 certainly looks like a bubble. Oil has become a classic financial asset, and assets are subject to bubbles. Some of the peculiar historical dynamics of the period may have coalesced in a fashion that fueled the type of investor beliefs that drive bubbles. Nevertheless, it is not easy to prove that the oil price was experiencing a bubble. The benchmark for the right fundamental price is even more elusive for a commodity like oil than it is for equities or for housing. On the one hand, that means it should be even easier for a bubble to arise, while on the other, it makes it harder to recognize. That said, the argument that the lack of above-ground storage proves the oil price was not a bubble has no merit and is based on an old mind-set about oil prices. The price movements of 2003–08 would not have driven an accumulation of above-ground storage, whether the price movements were caused by changing fundamentals or by the foolish beliefs that drive a bubble.

The fundamental equilibrium price of oil clearly shifted up in this period. It is unfortunate that many of those arguing that the oil price was being moved by speculators seem to want to minimize any role for fundamental factors; they seem to think that but for speculators, the price of oil might be back at $30 a barrel. This is putting one's head in the sand. But both sides seem guilty of treating the two potential causes of the oil price run-up—namely, fundamentals and financial speculation—as if they were mutually exclusive. The global macroeconomy has just experienced a period of large financial imbalances and funds looking for a home. Housing and real-estate prices appreciated significantly in several countries, an appreciation that is widely, though not universally, accepted to have been a bubble. As I show in this paper, it was precisely at this time that the oil markets were becoming widely available as a financial asset. Through an accident of historical coincidence, the rising fundamentals produced exactly the run of high returns that often drive irrational beliefs that a given investment can only go up, as was the case in many housing and real-estate markets. This is the dynamic of beliefs that underlies bubbles. I do not argue that the oil price spike was exclusively caused by financial speculation, but financial speculation is part of the story. This dynamic of the financial speculation is also connected to the history of fundamentals. This interplay has been overlooked in the discussion to date.

Comment

Ramón Espinasa: John Parsons's paper underplays the importance of the market forces underlying price evolution over the last decade. The huge development of the futures market that Parsons so well describes and analyzes may have amplified price oscillations since 2003, but such movements originated in real market imbalances. It was not just a financial bubble: it had foundations in the real market.

Prices remained remarkably stable in real terms in the fifteen years between 1986 and 2001, as growth in world demand was met through several sources. There was a sustained increase in supply from members of the Organization for Economic Cooperation and Development (OECD), particularly from the North Sea and Mexico; a steady increase in supply from non-OECD, non-OPEC countries; and, above all, an expansion of production from the Organization of Petroleum-Exporting Countries (OPEC), by making use of the excess capacity in place since their failed attempt to defend prices by cutting down production in the first half of the 1980s. The real oil price increased just 0.5 percent a year, on average, between 1986 and 2001, while world oil demand grew 1.6 percent a year in the period, with very similar rates for the OECD and non-OECD countries. The increase in demand was reflected in a growth of output of 0.7 percent a year among OECD countries and 1.1 percent a year among non-OECD, non-OPEC countries. However, the bulk of supply came from the OPEC countries, which increased their production by 3.3 percent a year in the period.

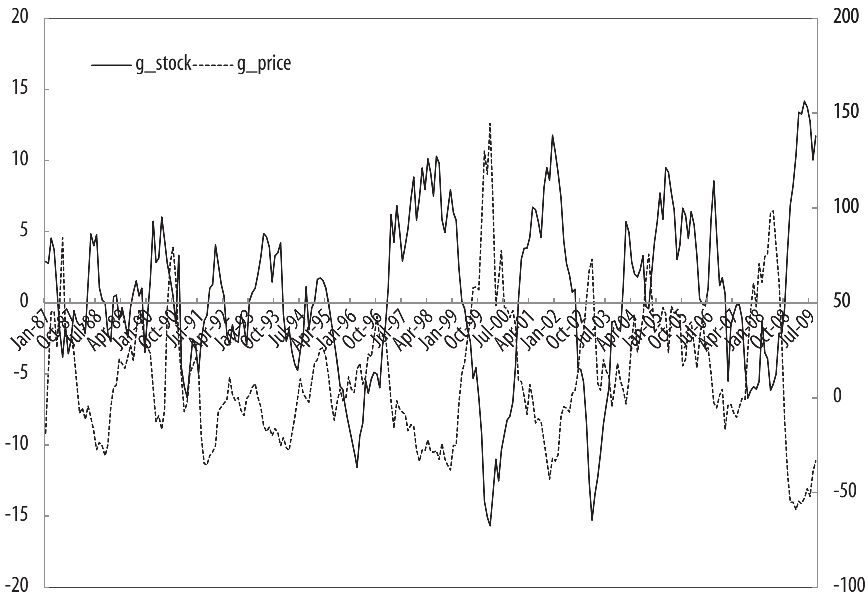
Prices accelerated sharply between 2002 and 2005 because of a sudden increase in world oil demand coupled with a sharp unexpected drop in supply in the OECD countries, particularly in the North Sea, and in some OPEC countries. Real prices increased by 26 percent a year between 2002 and 2005. The considerable upward pressure on prices stemmed from an increase in world demand, which grew 2.1 percent a year. In particular, accelerating growth in the non-OECD countries, most notably in Asia, caused their demand for oil to increase 3.9 percent a year, more than twice as fast as in the previous fifteen years. However the pressure on prices came mainly from unexpected shortfalls in supply. First, a sharp drop in production in the North Sea basin translated into a drop in overall OECD supply of 1.7 percent a year at the time when world demand was accelerating. Second, Iraq and Venezuela shut down their production in 2002–03. This put additional pressure on the rest of OPEC, which was very rapidly approaching full capacity utilization. Thus, the sharp surge and the shift in demand toward the Far East in 2002–03 were met by an unexpected drop in supply from three large exporting areas: the Caribbean, the Persian Gulf, and the North Sea. This undoubtedly created an environment for speculative action, based on real imbalances.

Finally, prices began falling with demand in 2006, and OPEC cut production to shore up prices. Demand then surged throughout 2007, while production dropped sharply and unexpectedly in Mexico. This recreated the conditions for a huge, though short-lived, surge in prices, no doubt fueled by speculative financial capital. Prices collapsed in the second half of 2008, as OPEC reacted to the surge and the world economy entered recession following the financial crisis.

Perhaps one of the most forceful arguments against the speculative financial capital explanation of the oil price surge in 2003–08 is the behavior of inventories and prices. If it was a bubble, inventories should grow regardless of short-term price fluctuations.

This was not the case. Figure 8 shows the monthly year-on-year growth rate of both prices and inventories. The two growth rates display a clear inverse correlation. This very much argues in favor of prices being moved by changes in real imbalances reflected in inventory changes and not by speculative action. To explore this graphical evidence further, I estimated controlled correlations. Results are presented in tables 2 and 3. The results show a very strong and significant negative correlation between prices and inventories. Table 2 shows the correlation from the market perspective, with prices as the dependent variable. Price changes correlate inversely to changes in inventories. The correlation is particularly strong in the period of fastest price growth, 2002–05. Table 3 shows the correlation from the perspective of the inventory holder, with inventories as the dependent variable. If the oil price spike was a speculative bubble, there should not be such a strong negative correlation between inventories and prices.

FIGURE 8. Monthly Year-on-Year Variation of U.S. Petroleum Stocks and WTI Nominal Price



Source: U.S. Energy Information Administration.

TABLE 2. Correlation of the Oil Price and U.S. Petroleum Stocks

Explanatory variable	*(1)* *1986–2009*	*(2)* *1987–2001*	*(3)* *2002–05*	*(4)* *2006–09*
Inventories	−0.684***	−1.821***	−0.522**	−5.990***
	(0.13)	(0.18)	(0.23)	(0.58)
Constant	0.000	−23.424	21.938*	45.144***
	(1.18)	(21.31)	(12.45)	(9.50)
Summary statistic				
No. observations	1,265	778	207	208
R squared	0.01	0.76	0.92	0.79

* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.
a. The dependent variable is the real oil price. Variables are expressed in logs and are demeaned. Estimation includes weekly, monthly, and yearly controls. Robust standard errors are in parentheses.

TABLE 3. Correlation of the Oil Price and U.S. Petroleum Stocks

Explanatory variable	*(1) 1986–2009*	*(2) 1987–2001*	*(3) 2002–05*	*(4) 2006–09*
L.rpo	–0.021***	–0.101***	–0.073**	–0.102***
	(0.00)	(0.01)	(0.03)	(0.01)
Constant	0.020	10.018***	–7.916***	6.195***
	(0.20)	(1.41)	(2.28)	(1.43)
Summary statistic				
No. observations	1,260	776	206	208
R squared	0.01	0.85	0.79	0.92

** $p < 0.05$.
*** $p < 0.01$.
a. The dependent variable is U.S. crude oil stocks. Variables are expressed in logs and are demeaned. Estimation includes weekly, monthly, and yearly controls. Robust standard errors are in parentheses.

To end, an aspect worth studying in future research is how the amplitude of the price oscillations in reaction to changes in fundamentals has increased with the huge growth of the futures market over the last decade.

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