Abstract
Should an investor enter into long-term positions in oil futures contracts? In answering this question, this paper will cover the following three considerations: (1) the case for structural positions in crude oil futures contracts; (2) useful indicators for avoiding crash risk; and (3) financial asset diversification for downside hedging of oil price risk. This paper will conclude by noting the conditions under which one might consider including oil futures contracts in an investment portfolio.

This paper is provided for educational purposes only and should not be construed as investment advice or an offer or solicitation to buy or sell securities or other financial instruments. The views expressed in this article are the personal opinions of Hilary Till and do not necessarily reflect the views of institutions with which Ms. Till is affiliated.

Research assistance from Katherine Farren, CAIA, of Premia Risk Consultancy, Inc. is gratefully acknowledged.

EDHEC is one of the top five business schools in France. Its reputation is built on the high quality of its faculty and the privileged relationship with professionals that the school has cultivated since its establishment in 1906. EDHEC Business School has decided to draw on its extensive knowledge of the professional environment and has therefore focused its research on themes that satisfy the needs of professionals.

EDHEC pursues an active research policy in the field of finance. EDHEC-Risk Institute carries out numerous research programmes in the areas of asset allocation and risk management in both the traditional and alternative investment universes.
The Case for Structural Positions in Crude Oil Futures Contracts

Portfolio Diversification
Why have asset allocation models typically included structural positions in crude oil futures contracts? The reason is primarily portfolio diversification. In order for a commodity index to not only hedge bond investments against inflation, but also do so effectively for equity investments, the index needs to have a concentration in the petroleum complex, according to Froot (1995). Accordingly, the main commodity indices tend to be heavily weighted in the petroleum complex. What then drives returns in the petroleum futures complex? A nuanced feature of all futures markets, including in crude oil, is how important the structural shape of the futures curve has been for driving returns, at least over the long run.

Key Long-Term Return Driver: The Futures Curve
To clarify terminology, when a near-month futures contract is trading at a discount to more distant contracts, we say that the shape of the commodity futures curve is in “contango.” This is shown in Figure 1 for the first four New York Mercantile Exchange (NYMEX) WTI crude oil futures contracts, as of 4 March 2011.

Figure 1: West Texas Intermediate (WTI): Near-Month Futures Contracts are in “Contango”

![WTI Crude Oil Price Curve](source)


In contrast, when a near-month contract is trading at a premium to more distant contracts, we say that the shape of the commodity futures curve is in “backwardation.” This, in turn, is shown in Figure 2 for the Intercontinental Exchange (ICE) Brent crude oil futures contracts, also as of 4 March 2011.

Figure 2: Brent: Near-Month Futures Contracts are in “Backwardation”

![Brent Crude Oil Price Curve](source)

Over sufficiently long time frames, an individual futures market’s returns have tended to be related to the commodity’s structural futures curve shape. In particular, Figure 3 shows that the commodity futures contracts that have had the highest returns have tended to be those in which the front-month contract traded at a premium to the deferred-delivery contracts; that is, those contracts that had the highest levels of “backwardation” had the highest returns. This figure uses data from 1983 to 2004. Correspondingly, the contracts that have had the most negative results tended to be those that typically traded at a discount to the deferred-delivery contracts; again, those contracts that had the highest levels of “contango” on average had the lowest returns.

*Figure 3: Annualised Return Vs. Average Annual Backwardation (1983-2004)*

Figure 4 provides updated results from 1999 through June 2014. This particular graph shows each contract’s excess return over T-bills vs. the contract’s roll return. The roll return, in turn, provides a measure of the average structural shape of the futures curve.

*Figure 4: Roll Returns and Excess Returns 1/1999-6/2014*
Figures 3 and 4 illustrate that the average return for a futures contract has been related to its curve shape. Also, the top performing contracts were generally in the petroleum complex, which, in turn, tended to have the highest average levels of backwardation. Therefore, should the decision on whether to enter into crude oil futures contracts depend on the contract’s curve shape? At least historically, the answer has been yes.

Figure 5 shows how *substantial* the return difference has been, depending on whether one holds WTI oil futures contracts unconditionally versus only if the first-month futures price minus the second-month futures price is positive; that is, if the front-to-back spread is in backwardation.

The annualised returns from 1987 through the end-of-August 2014 for holding and rolling WTI futures contracts were 6.2% per year over T-bills. Correspondingly, the returns over the same period for only holding a WTI futures contract when the contract’s front-to-back spread was in backwardation were 12.8% per year over T-bills. We can also examine more recent results. Starting in July 2014, the Brent futures market went into contango pretty much continuously, as shown in Figure 6.
If one had elected to only buy and roll Brent futures contracts when the contract was backwardated, then one's returns would have been quite different from the returns of a passive exposure to Brent futures contracts. These results provide further (but not conclusive) evidence for using a curve toggle for deciding upon whether to have exposure to crude oil futures contracts. (One should note that WTI futures contracts did not go into continuous contango until the end of November 2014, but one did have advance warning through the Brent futures curve structure.)

At this point, an obvious query would be: what is the fundamental reason for the curve shape being useful as a toggle for deciding on whether to enter into crude oil futures contracts? This will be covered in the next section of this paper.

Useful Indicators for Avoiding Crash Risk

Avoiding Crash Risk During Times of Low Spare Capacity

If one accepts that a crude oil-based investment is an advisable diversifying asset for a balanced portfolio of stocks and bonds, is there a way to potentially avoid the crash risk of a crude oil holding? An inspiration for answering this question can be found in an International Monetary Fund (IMF) Working Paper, namely, Nozaki (2010). The author discussed the currency carry strategy where an investor takes "a short position in a currency with a low interest rate and a long position in a currency with a high interest rate." This strategy's returns have had a "high Sharpe ratio, but its returns ... [have also been] negatively skewed"; the currency carry trade is "subject to crash risk."

The IMF researcher then described a fundamental valuation metric for foreign currencies (relative to the U.S. dollar) based on (1) each country's "commodity-based terms of trade" and (2) each country's "GDP per capita relative to its trading partners." In a fundamental trading strategy, one would take a "long (short) position in a foreign currency if it is undervalued (overvalued) in comparison to its 'fundamental' value." Relative to the carry trade strategy, the fundamental strategy generally has "a lower Sharpe ratio but [with] positively skewed returns."

Next, the IMF researcher looked into the performance of the following "hybrid" strategy. By default, one would be in the carry trade strategy. But one would "switch from the carry trade strategy to the fundamental strategy if the overvaluation or undervaluation of the foreign currency" was beyond a threshold level. In other words, at fundamental valuation extremes, one toggles out of the carry strategy into the fundamental strategy. This strategy is evaluated using "monthly observations from February 1985 to December 2008."

The researcher found that this "hybrid" strategy "had a relatively high Sharpe ratio" and was "less negatively skewed" compared to the pure carry strategy. The results "suggest that the hybrid strategy could offer some insurance against crash risk without sacrificing a high risk-adjusted average return achieved by the carry trade strategy."

Can we apply Nozaki (2010)'s insight to passive holdings of crude oil futures contracts? This paper will argue yes. In the case of crude oil, what candidates do we have for fundamental metrics? Arguably, the relevant metrics are (1) spare capacity; and (2) the inventory situation.

The current definition of spare capacity is as follows. The U.S. Energy Information Administration (EIA, 2014) has defined "spare capacity as the volume of production that can be brought on within 30 days and sustained for at least 90 days. ... OPEC spare capacity has provided an indicator of the world oil market's ability to respond to potential crises that reduce oil supplies."
To motivate why the spare capacity situation might be quite important to the behaviour of crude oil prices, one can review the circumstances of 2008. We found out from the events of that year what happens when the oil excess-capacity cushion becomes quite small. In July 2008, the role of the spot price of oil was arguably to find a level that would bring about sufficient demand destruction so as to increase spare capacity, after which the spot price of oil spectacularly dropped. This explanation is drawn from researchers from both the Federal Reserve Bank of Dallas and the U.S. Commodity Futures Trading Commission.

Figure 7 excerpts from a Federal Reserve Bank of Dallas paper. The red line shows WTI prices while the blue line is OPEC excess capacity. When OPEC excess capacity levels reached pinch-point levels, the price of crude oil responded by exploding.

Figure 7: Reduced OPEC Excess Capacity Helped Tighten Market

![Figure 7: Reduced OPEC Excess Capacity Helped Tighten Market](image)

Graph based on Plante and Yücel (2011), Chart 2.

[The red line is WTI prices while the blue line is OPEC excess capacity.]

Authors' Notes: Oil prices are monthly averages.

Sources of Data: U.S. Energy Information Administration (EIA) and the Wall Street Journal.

Figure 8 provides another way of illustrating what happened to the price of crude oil as OPEC spare capacity collapsed.

Figure 8: WTI Spot Price vs. OPEC Spare Capacity (Jan 1995 to Aug 2008)

![Figure 8: WTI Spot Price vs. OPEC Spare Capacity (Jan 1995 to Aug 2008)](image)

Source of Graph: Till (2014), Slide 19.

Sources of Data: The WTI Spot Price is the "Bloomberg West Texas Intermediate Cushing Crude Oil Spot Price," accessible from the Bloomberg using the following ticker: "USCWTIC <index>."

The OPEC Spare Capacity data is from the U.S. Energy Information Administration’s website.

Presenting data in this fashion is based on Büyüksahin et al. (2008), Figure 10, which has a similar, but not identical, graph. Their graph, instead, shows "Non-Saudi crude oil spare production capacity" on the x-axis. In Büyüksahin (2011), Slide 49, the energy researcher shows that this relationship structurally changed after January 2009.
Figure 8 shows WTI oil prices on the y-axis and OPEC spare capacity on the x-axis. The blue dots are data-points from January 1995 to February 2004, while the pink dots are from March 2004 to August 2008, as OPEC spare capacity became ever lower. This graph is analogous to the typical economics-of-storage graph where the price of a commodity can become exponentially high when there are low enough inventories. In the case of crude oil, though, the relevant variable on the x-axis has been spare capacity, at least over the time frame represented by Figure 8.

The previously referenced IMF working paper showed the advantages of exiting a high-carry foreign currency if its fundamental valuation surpassed a threshold level. It may be the case that one appropriate fundamental variable to monitor in the case of crude oil is spare capacity. Specifically, one should consider toggling out of an oil futures position when there is an indication of low spare capacity in order to avoid the potential of an eventual crash risk. How would the returns from a structural position in oil futures contracts have been affected if one used this fundamental variable? The answer is that, historically, negatively skewed returns became positively skewed.

Over the period, February 1999 through January 2015, if one unconditionally bought and rolled Brent futures contracts, the returns were 1.2% per month and were negatively skewed. These results exclude the returns from fully collateralising one's futures contract holdings. However, if one only held Brent futures contracts when OPEC spare capacity was greater than 1.8 million barrels per day, the returns became 1.7% per month and the returns were positively skewed, as shown in Figure 9. With this strategy, one only held crude oil futures contracts 73% of the time, and the returns shown in the middle column of Figure 9 were only calculated when this spare-capacity condition held.

![Figure 9:](source_of_brent_futures_data_the_bloomberg_the_bloomberg_ticker_used_for_calculating_brent_futures-only_returns_is_spgsbrp-index-source_of_opec_spare_capacity_data_eia_2015_table_3c_explanation_of_abbreviation_mpd_stands_for_million_barrels_per_day_necessary_caveats_these_results_would_only_be_appropriate_for_trading_or_investment_purposes_if_a_the_eia_s_monthly_data_has_not_required_substantial_revisions_after_publication_and_b_if_the_state-of-the-world_represented_by_an_empirical_analysis_over_the_period_1999-through-the-present_continues_to_be_the_case_both_assumptions_cannot_be_guaranteed_returning_to_figures_7_and_8_when_supply-and-demand_in_the_oil_markets_had Been_balanced_so_tightly_in_2008_a_number_of_incidental_factors_seemed_to_come_Into_play_in_contributing_to_the_oil_price_spike_in_2008_these_incidental_factors_included_a_temporary_spike_in_dieselImports_by_china_in_advance_of_the_beijing_olympics_purchases_of_light_sweet_crude_by_the_u.s_department_of_energy_for_the_strategic_petroleum_reserve_instability_in_nigeria_and_tightening_environmental_requirements_in_europe_now_even_though_the_oil_price_spike_in_2008_was_arguably_due_to_fundamental_factors_somemarket_participants_may_have_to_take_into_consideration_the_political_environment_that_they_operate_in_figure_10_shows_how_often_a_variant_of_the_word_speculate_appeared_in_a_september_2008_u.s_senate_hearing_this_particular_word_usage_spiked_in_comparison_to_other_named_fundamental_causes_of_the_oil_price_rally_of_the_time)
For some market participants, it may be advantageous to avoid crude oil futures exposure when there is minimal global oil spare capacity so that their investment or trading strategy would not be labelled as “predatory.”

In review, when oil spare capacity reached pinch-point levels, oil prices spiked higher, creating demand destruction, followed by the price of oil consequently crashing. Interestingly, Goldman Sachs analysts had predicted precisely this scenario in 2005, which came to pass three years later, as shown in Figure 11.

Figure 11: WTI Oil Price in 2005 Dollars

Avoiding Crash Risk During Times of Ample Supply Relative to Demand
A market participant should also consider toggling out of an oil position when there is evidence of ample supply relative to demand.

Crude oil inventory data are either not timely or, in the case of global data, not reliably available. Can we potentially use a price-relationship variable to proxy for ample supply relative to demand?
If the answer is yes, has the use of this price-relationship variable historically improved returns during times of economic downturns and market-share price wars? The answer to both questions has historically been yes.

As shown in Figure 12, when crude inventories have been ample, the front-to-back spread has been in contango; and when inventories were scarce, the front-to-back spread has been in backwardation.

Figure 12: Inventories vs. Market Contango/Backwardation

Historically, a toggle based on the front-to-back spread has provided further downside risk protection, as shown in Figure 13.

Figure 13:

<table>
<thead>
<tr>
<th>Conditional Solely on Previous Month’s OPEC Spare Capacity &gt; 1.8 mbd</th>
<th>Brent Futures (Excess) Returns February 1999 through January 2015</th>
<th>Conditional on Previous Month’s OPEC Spare Capacity &gt; 1.8 mbd AND Brent Front-to-Back Spread &gt; 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arithmetic Average Monthly Returns</td>
<td>Based on Monthly Data Arithmetic Average Monthly Returns</td>
<td></td>
</tr>
<tr>
<td>Skew</td>
<td>1.7%</td>
<td>0.42</td>
</tr>
<tr>
<td>Minimum</td>
<td>-19%</td>
<td>Minimum</td>
</tr>
</tbody>
</table>

Source of Brent Futures Data: The Bloomberg. The Bloomberg ticker used for calculating Brent Futures-Only Returns is “SPGBRP <index>.” Source of OPEC Spare Capacity Data: EIA (2015), Table 3c. Explanation of Abbreviation: “mpd” stands for million barrels per day.

Necessary Caveats: These results would only be appropriate for trading or investment purposes if (a) the EIA’s monthly data has not required substantial revisions after publication; and (b) if the state-of-the-world represented by an empirical analysis over the period, 1999-through-the-present, continues to be the case. Both assumptions cannot be guaranteed.

The strategy, conditional on both ample spare capacity and the Brent futures curve trading in backwardation, is positively skewed with its worst monthly return being -15%. In this case, one only held crude oil futures contracts 45% of the time, and the returns shown in the right-hand column of Figure 13 were only calculated when both conditions held.
A strategy of historically only entering into Brent futures contracts when (1) there has been sufficient spare capacity and (2) when there has been low inventory (as implied by the futures curve) has had appealing option-like characteristics. This dynamic allocation strategy has historically behaved as if it owned collars on crude oil. Collars are a combination option strategy of owning long out-of-the-money puts financed by shorting out-of-the-money calls while simultaneously owning the asset. Figure 14 shows how, across quartiles of Brent returns, the conditional strategy essentially gave up the possibility of very large returns in exchange for avoiding quite negative returns. This type of graphical analysis was drawn from Fung and Hsieh (1999).

Figure 14: “Conditionally Entered” vs. “Unconditionally Entered” Brent Crude Oil Futures (Excess) Returns End-January 1999 through End-December 2014

Now, at this point, one may be willing to concede that both the curve shape and spare capacity figures are helpful in deciding upon structural holdings in crude oil futures contracts. But is this information useful now when it appears that for the time being, OPEC Gulf producers have shaken off their traditional role of balancing the oil market? Saudi Arabia and other Gulf oil producers had until recently acted as the central banker of the oil market and had essentially provided a free put to the marketplace in preventing a free fall in oil prices, even in the face of new oil production, particularly from the United States. Arguably, one might compare the current price environment to 1986 when Saudi Arabia and other Gulf producers apparently decided upon prioritising market share, according to Gately (1986). Figure 15 shows the price path of crude oil in 1986. Drawing on Fattouh (2014), there was also ample OPEC spare capacity at the time. How did holdings in oil futures contracts perform in 1986, both unconditionally and when using a curve-shape toggle?
If one passively held and rolled WTI futures contracts, one would have lost -25.5% in 1986, as shown in Figure 16.

Correspondingly, during that time, if one only held WTI futures contracts and if the contract was backwardated, then the losses were significantly lower at -8.8%, again demonstrating the importance of curve shape as a signal.

In Summary, There are Two States of the World for Crude Oil Prices, Depending on the Spare-Capacity Situation

Figure 17 provides another illustration of how there are, arguably, two states-of-the-world in the oil markets; there is either sufficient spare capacity, or there is insufficient spare capacity.

The upper small graph on the left-hand-corner shows Oil prices (y-axis) vs. Forward demand cover in days.
The left-hand-side graph illustrates that the oil price had been highly correlated to the inventory situation before OPEC spare capacity started becoming an issue during 2004. This graph represents inventory as forward demand cover in days. The right-hand-side graph shows that once spare capacity came under pressure, oil prices became highly correlated to spare capacity as a percentage of world-wide demand. In both states of the world, the oil futures curve trading in contango provided a signal to consider toggling out of crude oil futures' allocations. This statement requires some additional explanation.

**Sufficient Spare Capacity**

When there is sufficient spare capacity, a futures curve can potentially be "backwardated" since there is no pressing need to incentivise precautionary stockholdings in oil. When there is sufficient spare capacity, the futures curve can also be in contango when there is ample supply relative to near-term demand.

In this state-of-the-world, the price of oil has been positively correlated to the front-to-back spread, as shown in Figure 18.

![Figure 18: WTI Front-to-Back Spread vs. Front-Month Crude Monthly Data 12/86 to 12/03](source)

Inadequate Spare Capacity

When there is insufficient spare capacity, a futures curve needs to be in "contango" since there is a pressing need to incentivise precautionary stockholdings in oil. Simultaneously, the market responds with a demand-destroying price spike to force the market into better balance, as seen in Figures 7 and 8. In this state-of-the-word, the price of oil has been negatively correlated to the front-to-back spread, as shown in Figure 19.

![Figure 19: WTI Front-to-Back Spread vs. Front-Month Crude Monthly Data 1/04 to 5/07](source)
Financial Asset Diversification for Downside Hedging

A dynamic allocation strategy alone has not been sufficient for holding the line against losses in a crude oil-dominated investment. Based on historical data, one should consider additional hedging mechanisms. One could potentially take advantage of the benefit of diversifying assets across different economic scenarios. Interestingly, from a portfolio construction standpoint, U.S. equity returns did fine in 1986 since declines in the price of crude oil are arguably like a tax cut for the economy, as shown in Figure 20.

The S&P returned 13.2% over T-bills during 1986. This provides evidence (but not conclusively) that to truly hedge a decline in oil prices, a dynamic allocation model may not be sufficient: superior portfolio construction may also be necessary. That is, one may need to include in one’s portfolio, assets that have a tendency to do well when the oil markets are performing poorly. This point was amplified in Driesprong et al. (2008) with a dataset from October 1973 through April 2003. These researchers found that across developed markets, on average, a decrease in one month’s oil price indicated a higher stock market return the following month. The impact of changes in oil prices on stock returns tended to be economically large. More recently, HSBC examined the connection between oil price declines and stock market performance over the succeeding year. According to Evans-Pritchard (2014), HSBC used data that stretched back to 1876 and found that U.S. equities rose on average by 11 per cent during previous 30%-plus drops in the price of oil, as shown in Figure 21. These results are a mirror image of what was covered at the outset of this paper: not only do petroleum futures contracts potentially hedge downdrafts in the equity markets, but the equity markets potentially hedge downdrafts in the oil markets.

Figure 20: S&P 500 Futures Excess Returns: 1986 Scenario

<table>
<thead>
<tr>
<th>S&amp;P 500 Futures Excess Returns:</th>
<th>13.2%</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Calculated based on rolling the futures contract on its last trading date]</td>
<td></td>
</tr>
</tbody>
</table>

Source of Data: Commodity Research Bureau.
Calculations by Joseph Eagleeye of Premia Research LLC.

Sources of Data: HSBC, Thomson Reuters Datastream, Global Financial Data.
Source of Table: HSBC, as reproduced in Evans-Pritchard (2014).
“Tumbling oil prices ... [have been] a bonanza for global stock markets, provided the chief cause has been a surge in crude supply rather than a collapse in economic demand,” wrote Evans-Pritchard (2014). But declining oil prices have not always preceded equity-market rallies. If oil prices are undergoing a dramatic decline because of "the forces of global recession", this can overwhelm "the stimulus or 'tax cut' effect for consumers and non-oil companies of lower energy costs," summarised Evans-Pritchard (2014). Under that scenario, a Treasury hedge may be the most effective hedge for petroleum complex holdings. For example, during the collapse of oil prices during the Great Recession and the Global Financial Crisis of the latter half of 2008, 10-Year Treasury Note futures returns were 13.8% above T-bills. Please see Figure 22.

**Figure 22: Crude Oil Prices and Treasury Note Futures Returns During 2H08**

![Graph showing crude oil prices and Treasury note futures returns during 2H08](source_of_data: The Bloomberg.)

10-Year U.S. Treasury Note Futures Excess Returns:
**Under 2H2008 Scenario**
13.8%

[Calculated based on rolling the futures contract on the first business day of the first-notice-day month.]

Source of Data: Commodity Research Bureau.
Calculations based on work by Joseph Eagleeye of Premia Research LLC.

**An Approach to Position-Taking in Crude Oil Futures Markets**

In conclusion, should investors potentially include oil futures contracts in their portfolios? One could argue that this is advisable only if the following three conditions are met:

(1) When the crude oil futures markets require price-risk-bearing services;

(2) When crude oil futures holdings are included in a diversified investment portfolio; and

(3) When the states-of-the-world that can be inferred from historical data can be expected to continue into the future.

**References**

• Evans-Pritchard, A., 2014, "Oil Drop is Big Boon for Global Stock Markets, If It Lasts," The Telegraph (U.K.), November 28.
Founded in 1906, EDHEC Business School offers management education at undergraduate, graduate, post-graduate and executive levels. Holding the AACSB, AMBA and EQUIS accreditations and regularly ranked among Europe's leading institutions, EDHEC Business School delivers degree courses to over 6,000 students from the world over and trains 5,500 professionals yearly through executive courses and research events. The School’s ‘Research for Business’ policy focuses on issues that correspond to genuine industry and community expectations.

Established in 2001, EDHEC-Risk Institute has become the premier academic centre for industry-relevant financial research. In partnership with large financial institutions, its team of ninety permanent professors, engineers, and support staff, and forty-eight research associates and affiliate professors, implements six research programmes and sixteen research chairs and strategic research projects focusing on asset allocation and risk management. EDHEC-Risk Institute also has highly significant executive education activities for professionals.

In 2012, EDHEC-Risk Institute signed two strategic partnership agreements with the Operations Research and Financial Engineering department of Princeton University to set up a joint research programme in the area of risk and investment management, and with Yale School of Management to set up joint certified executive training courses in North America and Europe in the area of investment management.

Copyright © 2015 EDHEC-Risk Institute