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A Follow-On Note Regarding the Recent Decline in the Price of Crude-Oil

Table of Contents

EXECUTIVE SUMMARY	2
OIL PRICES	3
CAPM APPROACH	6
IMPLIED VOLATILITIES	8
OVX INDEX	9
CONCLUSION	10

I. Introduction

As a special note and part of our on-going “Message from the Markets” series, we look to a variety of indicators from the financial and commodity markets in order to infer what they might tell us about the forward looking views of its participants – in particular, for those with a financial stake in the outcome.

Based on the notion markets are efficient aggregators of information, this approach is distinct from the analysis commonly reported in the news in that it deliberately refrains from an attempt to decipher the fundamental drivers of prices but instead looks to the what the markets tell us as a proxy for the true view of its participants, inclusive of all available information. It allows us to move past the views of pundits with no stake in the outcome as well as those espousing a view with a particular bias in mind.

This approach, we believe, allows for the clearest view of the expected outcomes that are “baked” into the markets and offers the only truly unbiased perspective on prospective prices.

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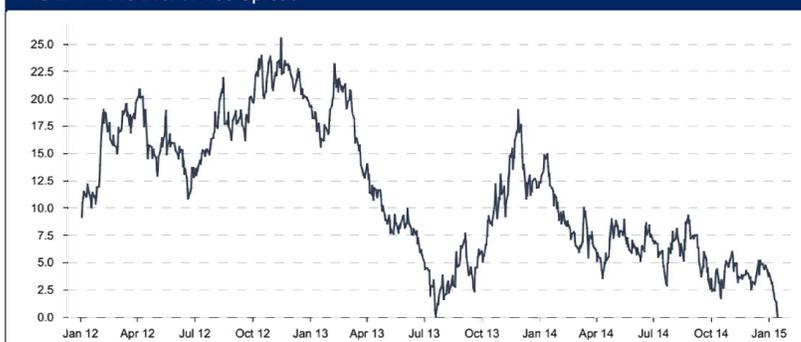
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FIG 1. WTI vs Brent Historical Prices



Source: Bloomberg, Guzman Energy

FIG 2. WTI vs Brent Price Spread



Source: Bloomberg, Guzman Energy

EXECUTIVE SUMMARY

II. Executive Summary

In our December edition of “Message from the Markets” (MFTM), we sought to provide analyses of and a perspective on the decline in Brent and WTI crude-oil prices by looking to the financial and commodity markets. Since then, as oil prices have continued their decline, to \$48.65 for North Sea Brent and \$48.57 for WTI, this issue delves more deeply into this analysis as well as attempts to provide some forward-looking observations as to where the market might be in one year.

There have been numerous reports regarding the possible geopolitical underlings of the recent decline in oil prices. Many of these have focused on the large oil producer in the Persian Gulf seeking to adversely impact its geopolitical opponent and/or shale oil producers in the U. S. While we are not able to refute these arguments, our analysis here focuses on the economics, not geopolitics, of the oil market.

Our analytical objectives are three-fold:

- To use both forward-looking and historical analyses to demonstrate oil prices one year hence are expected to be higher than they are now.
- In contrast to numerous analyses, to demonstrate the causality is from equity prices to oil prices, and not from oil prices to equity prices
- To confirm there is substantial uncertainty regarding the path of oil prices, but more substantially, there is concern for both a spike as well as a crash in oil prices, with even greater concern for the latter

From our analysis we are able to conclude that “the market” is willing to transact at prices that imply that the crude price will rise over the coming year, but that the magnitude of this price increase is modest relative to recent historical values. *Based on our analysis, the market expects the crude spot price to rise between 18.7% (57.67) and 40.4% (\$68.19) over the coming year.*

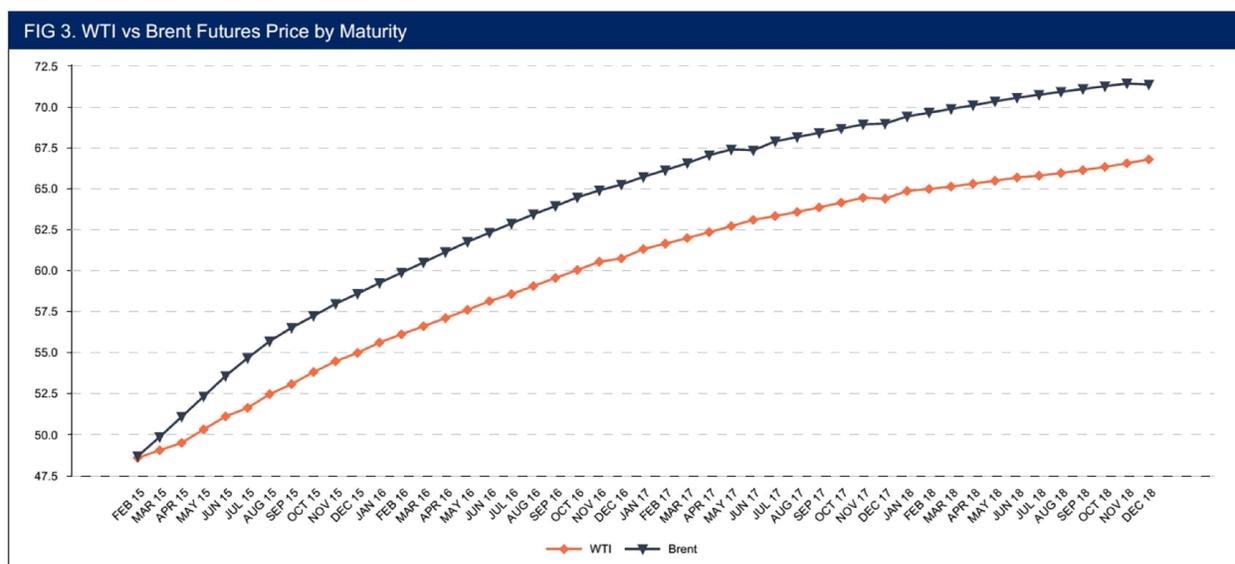
Further, despite the general view that the price will rise in the future, there remains significant concern that the market could see further declines in the interim, as evidenced by implied volatility seen in the market.

OIL PRICES

III. Whither Oil Prices?

While forecasting the future moves in oil prices is an always-hazardous task, we have several indications from markets as to the move in oil prices over the following twelve months:

- The **first** comes from the slope of the futures curve as currently observed. As can be seen from Figure 3, the WTI and Brent curves are currently in *contango*, with longer-dated futures trading above the spot price:

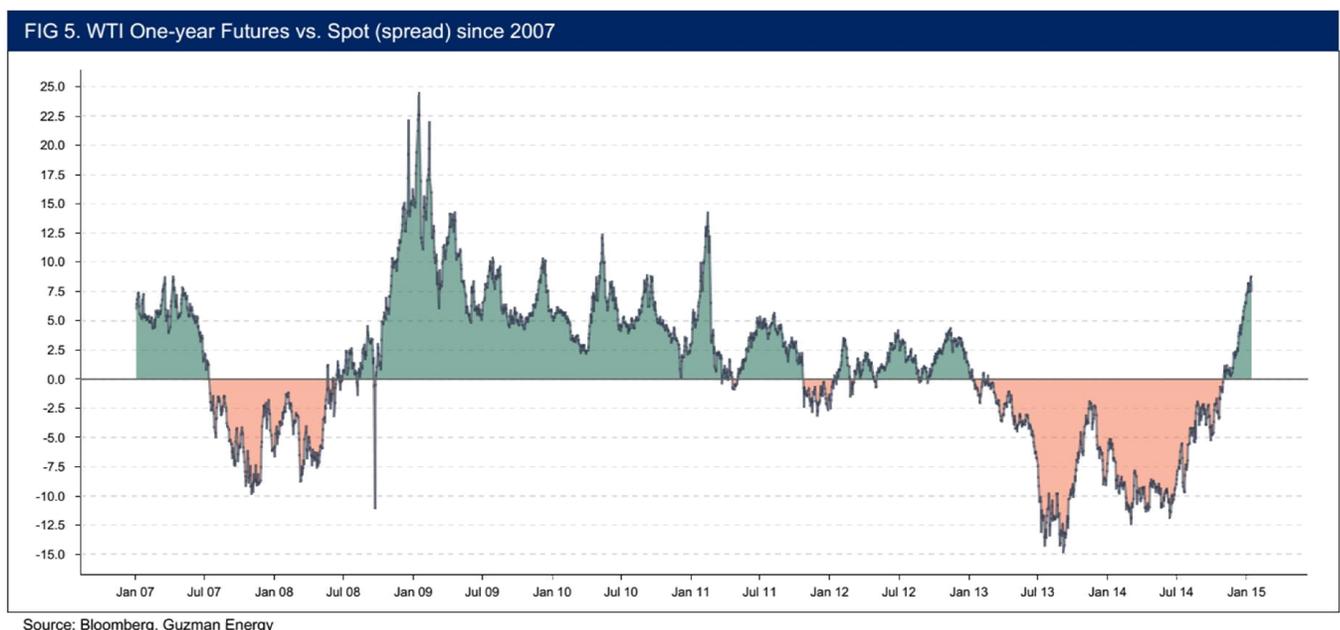
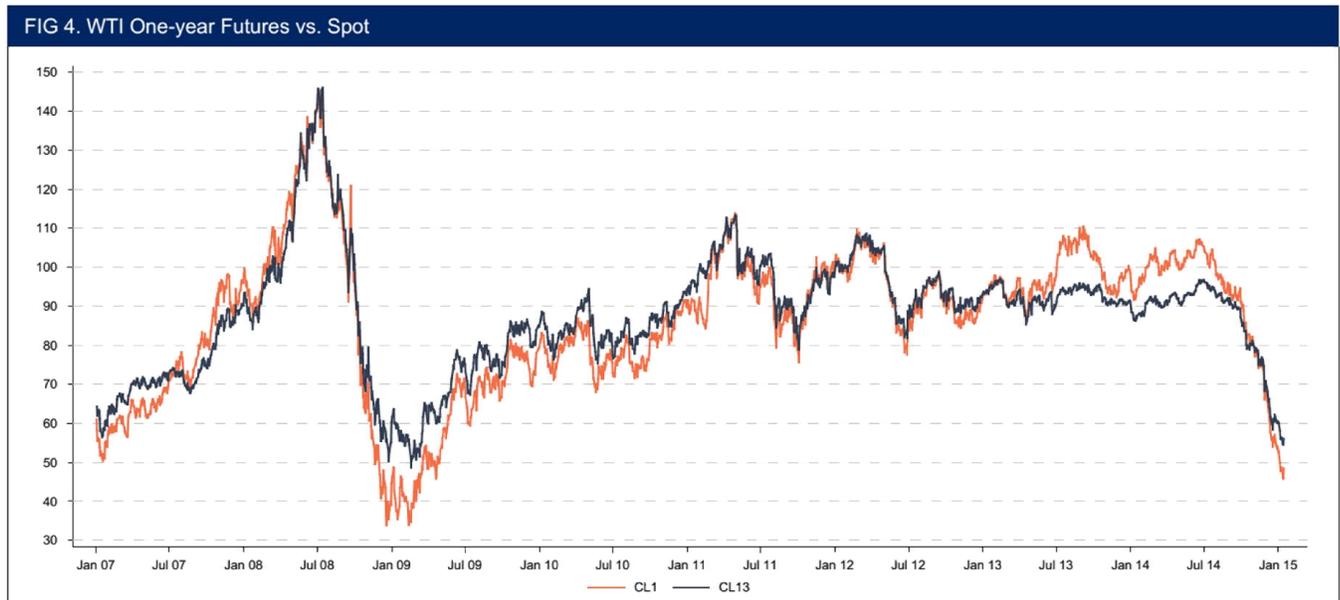


As is well-known, the shape of the current curve is dramatically different from the backwardation the curve evidenced as recently as Oct. 2014. To give this shape of the curve context, recall the last time markets were in this form. Perhaps the clearest comparison may be drawn with the 12/19/08 (for WTI) or 12/24/08 (for Brent) curves: These were the two dates at which oil prices bottomed out during the Great Recession. At that time, the difference between the one-year WTI contract and the prompt-month contract was of \$24.45.

CONTANGO

To bring that analysis up to date, there are two conclusions we can draw:

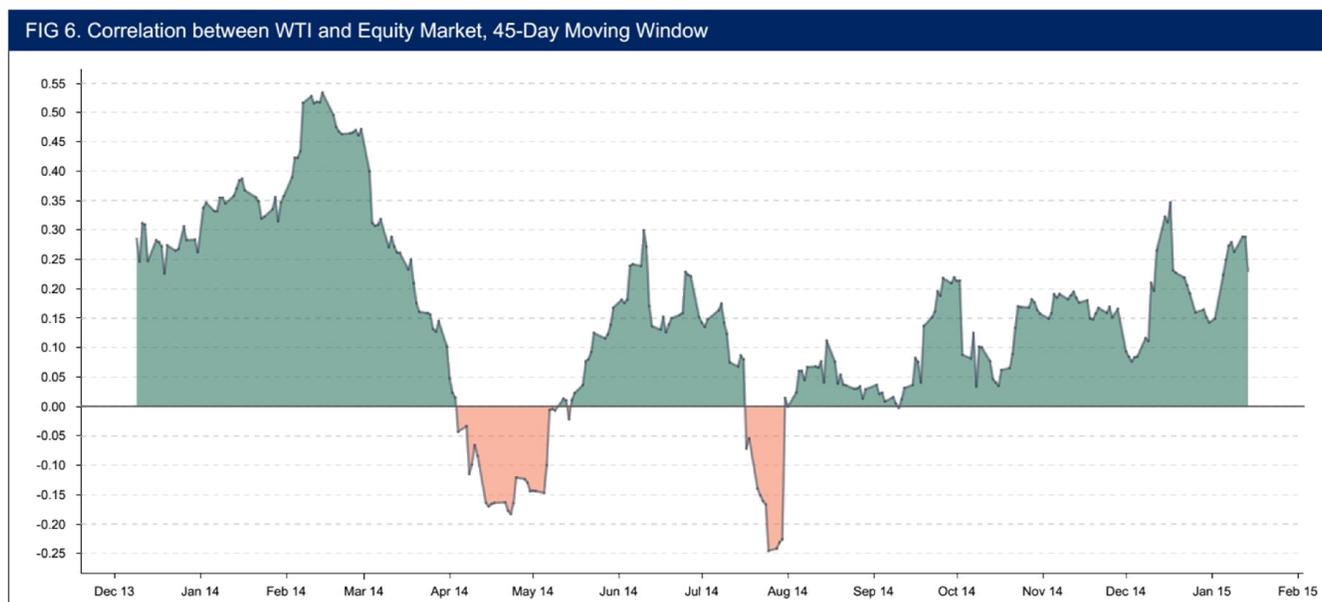
- a) As in 2008, the oil curves' current *contango* is a clear demonstration that prices are unusually low. Thus, while prices can of course head lower, the market is signaling this is unusual. (About 65% of the time the markets are *backwardated*, whereby the slope of the curve is negative.)
- b) Figure 4 and 5 depict the evolution of the price spread – between the WTI one-year futures and the spot-price – since 2007:



CORRELATION OF OIL AND EQUITY

The current slope is \$7.56, has been increasing steadily since Sep. 2013 and turned positive in Nov. 2014. The positivity of the current slope, while less pronounced than it was in Dec. 2008, is nevertheless reflective of the market's current perspective on the unusually-low spot price.

- The **second** indicator comes from the relationship between oil prices and equity markets: Per Figure 6 below, the current correlation (SPX, Oil Prices) is a positive 0.231.



Source: Bloomberg, Guzman Energy

Typically, we find that correlation is negative during times of geopolitical crises, when prices are elevated due to concern regarding the arrival of supplies to consuming markets. When correlations are positive, as they are at this time, the intuition of the Capital Asset Pricing (CAPM) implies expected prices in the future will be above their current futures prices. These futures prices, in turn, as Figure 4 indicates, are higher than current spot prices.

Whereas many analysts have been interpreting recent markets as “lower oil prices driving lower equity values,” the analysis here suggests the causality should be in the other direction: *Prospective lower growth in Asia and Europe, as reflected in lower equity values, is lowering demand for energy and thus driving down oil prices*

CAPM APPROACH

To quantify the above, consider the implications of applying a conditional CAPM approach:¹ In this approach, the expected rate of return on the one-year futures contract is given by:

$$\ln \left[E \left(\frac{CL_{1,1}}{CL_{13,0}} \right) \right] = \rho_0 * \sigma_0 * \lambda_0 \quad (1)$$

where:

$CL_{1,0}$ = Today's (time 0) value of the WTI spot (CL_1)

$CL_{13,0}$ = Today's (time 0) value of the 1-Yr. WTI futures contract (CL_{13})

$CL_{1,1}$ = Jan. 2016 (time 1) value of the WTI spot (CL_1). Note this is also the value of $CL_{13,0}$ in one-year's time

$E \left(\frac{CL_{1,1}}{CL_{13,0}} \right)$ = One plus expected rate of return on one-year's futures contract

ρ_0 = current correlation

σ_0 = implied volatility on CL13 contract

λ_0 = S&P market price of equity risk

At this time, Figure 6 reports $\rho_0 = 0.231$, whereas the crude-oil option markets current report $\sigma_0 = 35.3\%$. Using an equity market price of risk (i.e., the Sharpe Ratio) of 0.33,² we have

$$\ln \left[E \left(\frac{CL_{1,1}}{CL_{13,0}} \right) \right] = 0.231 * 0.353 * 0.33 = 0.027 \quad (2)$$

implying $E(CL_{1,1}) = 56.13 * e^{0.027} = \57.67 . In words, we expect the one-year futures contract to rise 2.74% to \$57.67, by the end of the year. In addition, this implies an expected increase in the spot price of $57.67 / 48.57 - 1 = 18.7\%$.

- The above analysis is purely forward-looking. One way to validate the above is to consider market behavior when we have in the recent past witnessed a contango market. Thus, consider an analysis of the market's behavior since the beginning of the Great Recession eight years ago.

As is well-known and has indeed been cited above, at any point in time we can observe the current slope of the futures curve. Thus, consider the implications of a contango market whenever such was recently observed. Using the above notation, *quantify* the contango by a simple measure: $CL_{13,0} - CL_{1,0} > 0$. In words, we quantify the contango by observing today's price of the one-year futures contract $CL_{13,0}$ is greater than the spot price $CL_{1,0}$. The question is, to what extent is this predictive of a rise in the spot price CL_1 over the next year.

1. The term "conditional CAPM" implies we are using this asset pricing model whilst "conditioning" on a current specific information set. In this case, that set will include the equity market price of risk, the correlation between the S&P and crude-oil prices, and the implied volatility on the one-year crude-oil futures contract.

Empirical support for the application of the conditional CAPM to oil prices may be found in a moving-window regression of futures' returns regressed on S&P 500 returns. In those regressions, it is found the intercept term is negatively correlated with the slope. One possible interpretation of these empirical results is that in the presence of a supply-side geopolitical shock, futures prices are upward-biased due to the risk premium. The converse is true in the presence of a demand-side (economic recession) shock.

2. For the estimate of the Sharpe Ratio, see <https://www.plannersfinancialservices.com/918764.pdf> updated to 2014.

CAPM APPROACH

To examine this question, consider calculating four alternative statistics:

- a) $\text{Prob}\{ CL_{1,1} > CL_{1,0} \mid CL_{13,0} > CL_{1,0} \}$. In words, this seeks the answer to the question, “*Conditional* on a contango situation today, what is the probability the spot price one year from now will be greater than the spot price today?”
One simple variant of this is: $\text{Prob}\{ CL_{1,1} > CL_{1,0} \mid CL_{13,0} - CL_{1,0} > 5 \}$. This condition is more demanding than its predecessor: We are now conditioning on the steepness of the slope (between the spot price and the one-year futures) exceeding \$5.
- b) $\text{Prob}\{ CL_{1,1} > CL_{13,0} \mid CL_{13,0} > CL_{1,0} \}$. Here we seek the answer to the question, “*Conditional* on a contango situation today, what is the probability the maturity value of the one-year futures contract is greater than that futures contract’s price today?” This question is most similar to the forward-looking one, since it posits a change in the price of a specific futures contract, and so is inherently a feasible trading strategy. Once again, we consider the variant $\text{Prob}\{ CL_{1,1} > CL_{13,0} \mid CL_{13,0} - CL_{1,0} > 5 \}$.
- c) $E(CL_{1,1} / CL_{1,0} - 1 \mid CL_{13,0} > CL_{1,0})$. Here we seek what statisticians call a conditional expectation: “*Conditional* on the curve being in contango today, what is the one-year *expected rate of change* on the spot price?” An additional statistic of interest here is: $E(CL_{1,1} / CL_{1,0} - 1 \mid CL_{13,0} - CL_{1,0} > 5)$.
- d) $E(CL_{1,1} / CL_{13,0} - 1 \mid CL_{13,0} > CL_{1,0})$. Conditional on a contango curve, this is now the conditional expectations of the rate of return on the one-year futures contract. The standard variant is of course $E(CL_{1,1} / CL_{13,0} - 1 \mid CL_{13,0} - CL_{1,0} > 5)$.

Table 1 – Information on Prospective Oil-Price Movements

Data Period: 1/8/2007 – 1/12/2015

Result \ Condition	$CL_{13,0} > CL_{1,0}$	$CL_{13,0} - CL_{1,0} > 5$
$\text{Prob}\{ CL_{1,1} > CL_{1,0} \}$	79.9%	97.8%
$\text{Prob}\{ CL_{1,1} > CL_{13,0} \}$	72.8%	86.2%
$E(CL_{1,1} / CL_{1,0} - 1)$	21.7%	40.4%
$E(CL_{1,1} / CL_{13,0} - 1)$	11.7%	22.3%

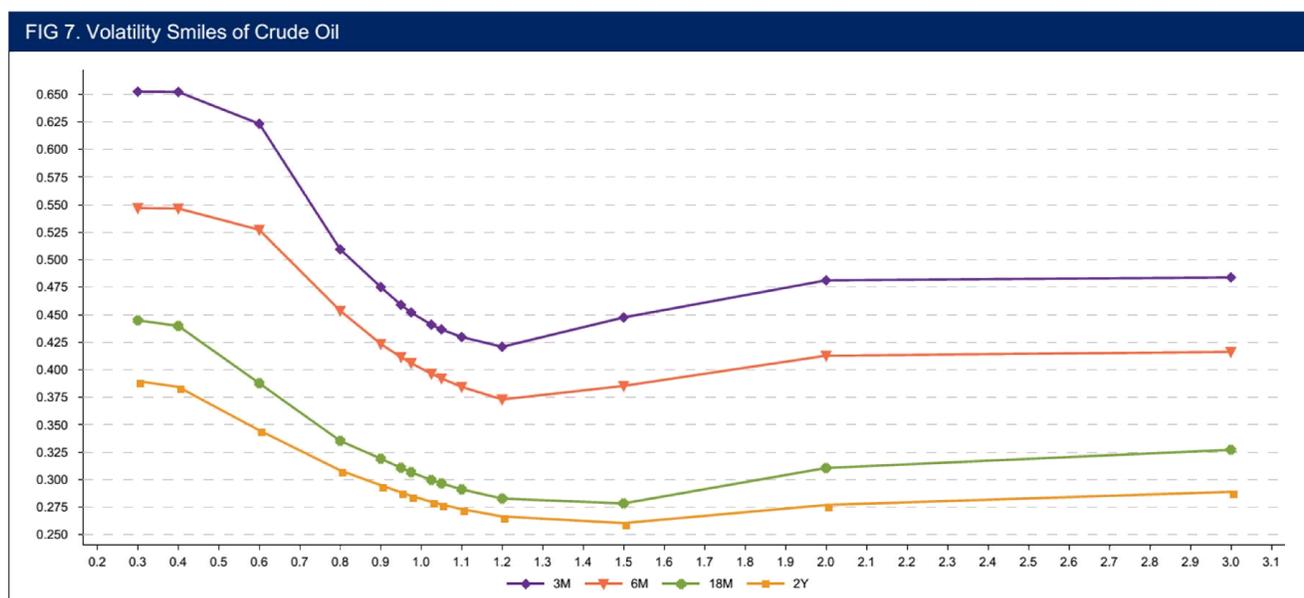
The latest data has $CL_{13,0} - CL_{1,0} = 7.56 > 5$, so the last col. in Table 1 provides the most salient data. While the results appear quite strong, they should be qualified they are based solely on the last eight years of data.

IMPLIED VOLATILITY

- Whereas many analysts have been interpreting recent markets as “lower oil prices driving lower equity values,” our analysis suggests the causality should be in the other direction: Prospective lower growth in Asia and Europe may be lowering demand for energy and thus driving down oil prices.

To examine this matter econometrically, we proceed with a bivariate Granger causality of the two key variables – oil prices and equity prices.³ In implementing this econometric test, we find statistically-significant evidence equity prices “Granger-cause” oil prices but the converse does not hold.

- In considering the volatility “skew,” we examine option markets’ concerns regarding large moves in oil prices, either up or down. In observing this volatility skew as reflected in the prices of options on WTI futures contracts, we find markets are concerned with large directional moves in both directions, but with an even-greater-concern regarding a possible *crash* in oil prices. To see this last, consider in Figure 7 the volatility skew in WTI futures options:



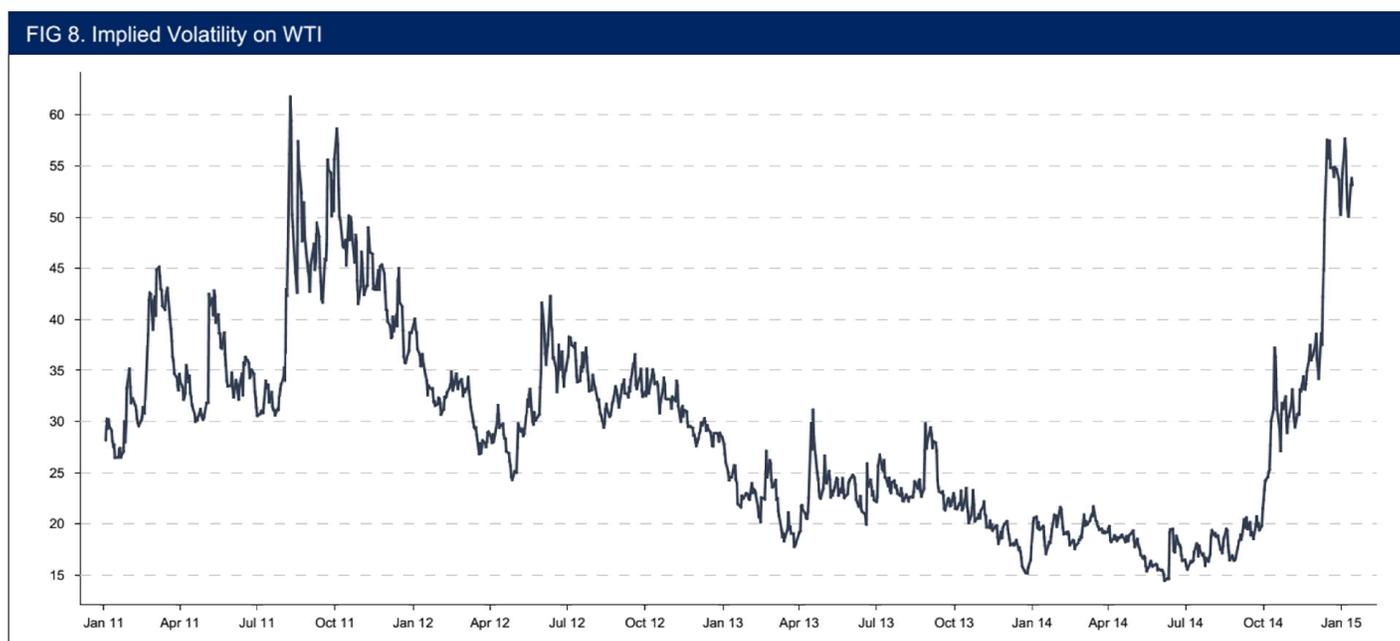
3. To quote wikipedia.org. “the Granger causality test is a statistical hypothesis test for determining whether one time series is useful in forecasting another. Ordinarily, regressions reflect ‘mere’ correlations, but Granger argued causality in economics could be reflected by measuring the ability of predicting the future values of a time series using past values of another time series. Since the question of ‘true causality’ is deeply philosophical, econometricians assert the Granger test finds only ‘predictive causality.’”

VOLATILITY INDEX

The volatility skew is defined as the futures options' implied volatility using the Black (1976) option-pricing model. The "U"-shaped nature of the volatility skew displayed above demonstrates markets are concerned with large moves in either direction. However, note the implied volatilities for options with moneyness (strike price divided by futures price) $K / F < 1$ are greater than the volatilities for those options with $K / F > 1$. This reflects option traders' greater concern there may be rapid large moves to the *downside* which they would be unable to Delta-hedge. This inability leads them to seek protection by pricing options with moneyness $K / F < 1$ at a higher implied volatility than ATM options ($K / F = 1$) or options with moneyness $K / F > 1$.

IV. OVX Values

Analogously to the equity market's VIX index, the OVX in Figure 8 represents the 30-day implied volatility on WTI futures options:



Source: Bloomberg, Guzman Energy

As usually happens during times of dramatic changes (up or down) in oil prices, the OVX 30-day oil implied volatility has more than doubled from its recent low of 16.5% on 8/27/14 to a current value of 53.2%, matching the fall 2011 peak: The markets are quite concerned about the direction and magnitude of future price moves.

CONCLUSIONS

V. Conclusions

The recent decline in Brent and WTI prices has been precipitous and sharp. While it is hazardous to describe when and at what price the trough of this decline might occur, the market's *contango* slope and positive correlation with equity markets indicate the markets see this decline as unusual and appear to display an expectation of reversion to higher prices.

While bullishness over the next one-year horizon is justified, the challenge lies in *quantifying* that expectation over this horizon. A purely forward-looking perspective anticipates an increase in the one-year futures contract of only 2.74%, and a concomitant increase in the spot price of 18.7%. In contrast, applying the curve's current *contango* measure to historical values over the past eight years – admittedly, a relatively short period of time – gives rise to a futures rise of 22.3% and a spot price increase of as much as 40.4%.

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