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The impact of fundamental and financial traders on the term structure of oil

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No. 209

The Impact of Fundamental and Financial Traders on the Term Structure of Oil

by Thomas Heidorn, Frieder Mokinski,
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Abstract

We study how the exposure of fundamental and financial traders affects the futures curve of WTI oil and the market integration between WTI and Brent as measured by their price spread. To obtain a parsimonious representation of the futures curve, we decompose it into a level-, a slope- and a curvature factor. In a second step, we separately regress each extracted factor on measures of the market exposure of fundamental and financial traders revealing whether and how the exposure of the two trader groups affects the different dimensions of the futures curve. Spanning from 2006 until 2012, our dataset covers sub-periods of a sharp WTI-price rise as well as a diverging Brent-WTI-spread. Our contribution is threefold: First, we suggest that it is important to distinguish between level and slope as we find that fundamental traders have a measurable impact on the level of the futures curve, but do not play much of a role for its slope or curvature, whereas the exposure of financial traders mainly influences the slope of the futures curve. Despite allegations to the contrary, we find no evidence of a systematic impact of non-fundamental traders on the level of the futures curve, for example during the 2006-2008 oil price surge. Second, we suggest using relative short- and relative long positions for fundamental and financial traders instead of the net position as the former reflect better the overall group exposure and yield more significant results. Third, we find that the exposure of financials is the key driver of the Brent-WTI spread. It confirms that financial rather than fundamental traders are responsible for integrating the two markets.

Key words: WTI, Price speculation, Oil price rise, Market Integration

JEL classification: Q40, G13

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1. Introduction

The crude oil price has been subject to increasing fluctuation over the last decade. As an example, [Figure 1](#) plots the evolution of the WTI-1M-future price and its 30 day volatility from June 2000 until December 2012. During that period the price fluctuated between 17.45 \$ and 145.29 \$ per barrel (left scale) and the 30 day volatility (standard deviation) between 0.10 \$ and 3.76 \$ (right scale). The volatility substantially increased from an average of 0.50 \$ for the period 2000-06 to 1.20 \$ for the period 2006-12.

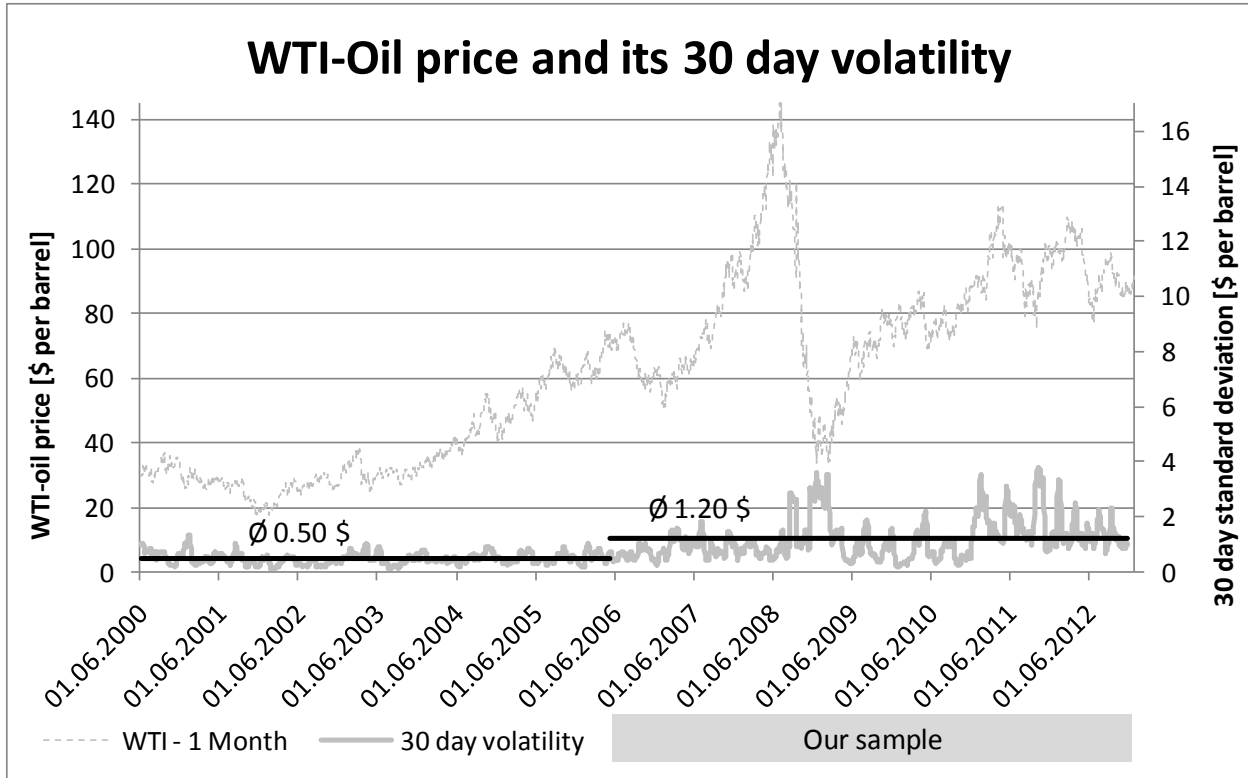


Figure 1 Crude oil price and –volatility from June 2000 until December 2012

This increase in market volatility coincided with an increased involvement of financial investors in the oil market. Michael W. Masters, a hedge fund manager, who testified several times before the U.S. Congress and Commodity Futures Trading Commission (CFTC) wrote in a report:

“In the last 4½ years assets allocated to commodity index replication trading strategies have grown from \$13 billion in 2003 to \$317 billion in July 2008.” (Masters, M. W. and A. K. White 2008)

The coincident rise of crude oil (spot and future) prices and the multiplication of the market segment by almost factor 25 have been seen as suggestive of a causal relationship, with fi-

nancial investors, in particular commodity index funds and hedge funds, inducing prices to rise above their fundamental levels, and by doing so, inducing higher price volatility.

Our goal is a better understanding of the impact of the market positions of financial and fundamental traders on the term structure of WTI and the spread between Brent and WTI.

To explore the impact of trading, we adopt an idea first used to study bond yield curves ([Nelson, C. R. and A. F. Siegel, 1987](#)) and decompose the oil future curves into three factors representing level, slope and curvature respectively. In a second step, we study whether these factors can be predicted from trader's positions by regressing each factor on the WTI-trading positions of fundamental and financial traders, controlling for freight rates, market liquidity and storage volume. In a third step we study the arbitrage behaviour of investors across markets, by replacing the WTI-curves by the spread curves ('Brent minus WTI') and re-running our analyses. We study the second period of [Figure 1](#), i.e. June 2006 until December 2012. To challenge the results obtained on the full sample, we verify whether they are robust enough to hold in periods where crude oil exhibited very particular price patterns. To this extent, we limit our sample first to the period from January 2007 to July 2008 where WTI's price per barrel almost tripled from 50 USD to 140 USD (we label this period 'Sharp rise'). In the same line of argument, we limit our sample to the period from April 2011 until December 2012 where the prices of Brent and WTI substantially diverged, leading to spreads of up to 28 USD per barrel, compared to a long-term average of close to zero.

In contrast to previous studies, we not only use the net position to describe traders' exposures but augment this by the share of fundamental traders on all short positions and the share of financial traders on all long positions, as position measures. [Figure 2](#) plots the relative market share on short positions against the WTI-prices from 2006 to 2012. Commodity index investments are typically hedged with future contracts resulting typically in long positioning for financial investors. [Figure 3](#) shows their relative market share on long positions plotted against WTI-prices.

Figure 2: The market share of fundamental traders on the overall short position,
Source: Commodity Futures Trading Commission

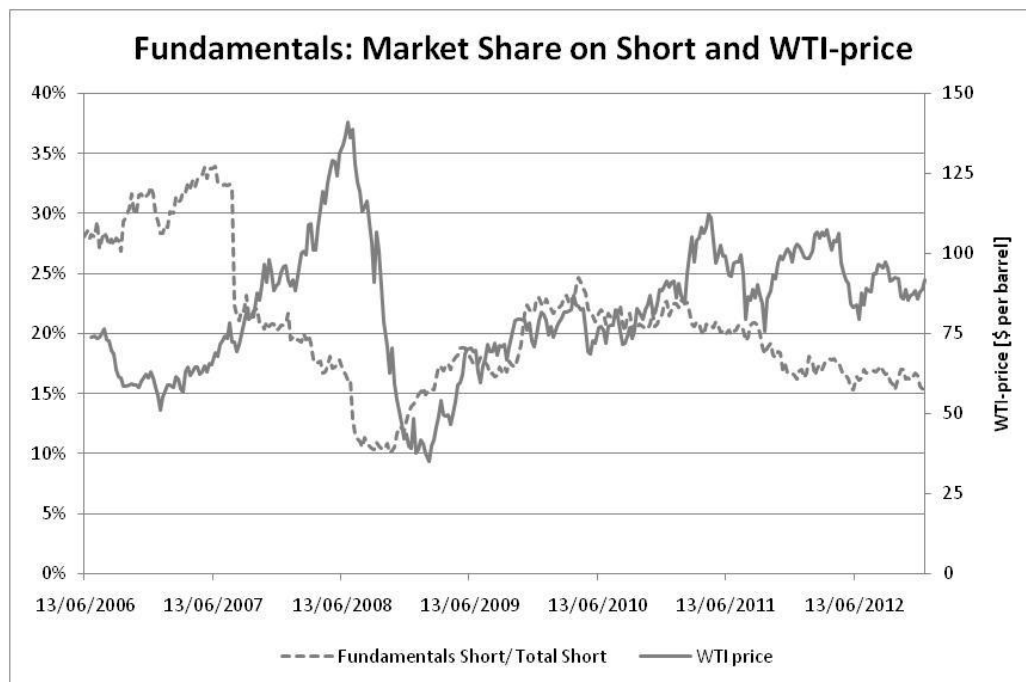
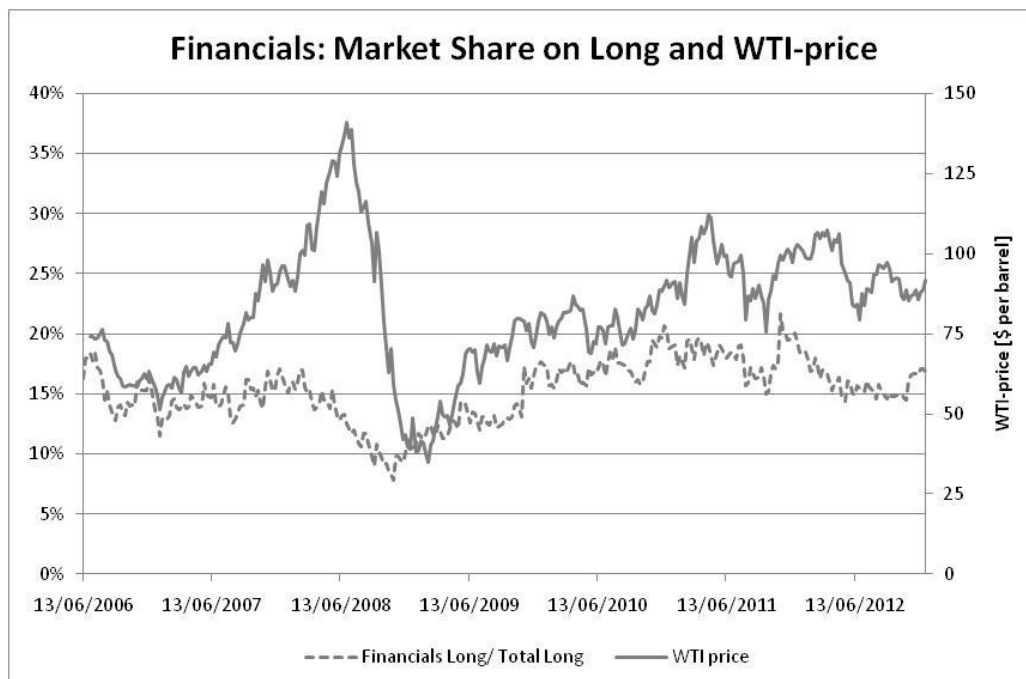


Figure 3: The market share of financial traders on the overall long position,
Source: Commodity Futures Trading Commission



The large and unprecedented price swings of the crude oil price during the last decade have triggered substantial research into the causes of this phenomenon. Much of the existing research has been motivated by the influx of financial investors into commodity futures markets including the market for crude oil futures which took place at the same time when prices of the respective commodities exploded. The phenomenon of increasing financial investor participation in commodity markets has been termed “financialization”. The literature on “financialization” studies whether the introduction of financial commodities (futures) or the participation of financial players affected the price correlation with other assets or price volatility. Stoll, H. R. and R. E. Whaley (2010) find that commodities for which financial futures do not exist have seen similar price rises from 2003 to 2008 as commodities for which financial futures do exist. Using data that date back until the late 19th century, Jacks, D. S. (2007) finds that the introduction of commodity futures has reduced spot price volatility in the respective commodity. Tang, K. and W. Xiong (2012) provide evidence that the increased correlation between non-energy commodities and crude oil futures from 2004 onwards might be due to commodity index investment as they find that correlations among the index constituents of the two major commodity price indexes – the Standard and Poor’s - Goldman Sachs Commodity Index (S&P GSCI) and the Dow Jones-UBS Commodity Index (DJ-UBS) – rose more strongly than the correlations among index constituents and non-index commodities. Summarizing, these studies have found evidence that financialization is likely to reduce price volatility. By contrast, there is little evidence that financialization has a systematic impact on price levels.

Another strand of the literature, in which our paper is located, studies whether specific trader groups have an impact on the crude oil price and its volatility. Most of these studies use the publicly available trader’s position data collected by the CFTC (Commodities Futures Trading Commission). Historically, the CFTC has only recorded, whether a trader is a commercial or a non-commercial, whereas a commercial has been defined as a party with a hedging interest (such as an oil producer, who sells futures as a hedge against fluctuating prices). And it has only reported end-of-the-week open interest to the general public, although it owns daily data. Throughout the last decade, the CFTC has started to introduce more precise categorizations of traders. Studies therefore differ both in the level of aggregation among trader types and in the time dimension, since some researchers affiliated to the CFTC have been granted access to daily data. Specifically, Brunetti, C. and B. Buyuksahin (2009) use non-public daily CFTC data allowing a distinction of the fund flows of hedge funds, swap traders, floor brokers/traders and several groups of investors that are interested in the physical commodity. Two main findings emerge in their analysis across several commodity markets: there is no Granger causality from positions to returns but from positions (specifically those of hedge funds) to volatility (more investment reduces volatility), and returns seem to Granger cause positions. These findings are well in line with speculators providing valuable liquidity to the market. Buyuksahin, B. and J. H. Harris (2011), using a longer series

of the same data and focusing on crude oil, confirm the results of Brunetti, C. and B. Buyuksahin (2009). Sanders, D. R. and S. H. Irwin (2011) test whether swap trader fund flow, which they use as a proxy for commodity index investment, predicts the returns of 14 commodities including crude oil. Using publicly available weekly data from the so-called disaggregate commitment of traders report published by the CFTC, they cannot reject Granger non-causality in any of the fourteen cases they consider. Similar to the aforementioned studies, they find some evidence indicating that increases in swap trader exposure can reduce crude oil price volatility. Irwin, S. H. and D. R. Sanders (2012) use a relatively novel report from the CFTC, the Index Investment Data report. According to the authors, this data provides the best measure of commodity index fund flows for the crude oil futures market so far. There is however one serious drawback: the time series is short and observed only on the quarterly frequency.¹ The authors make two contributions: They test the quality of existing proxies of commodity index investment, and find that it is poor. Moreover, they conduct Granger causality-like tests of the impact of commodity index funds on futures prices, and find little evidence of an impact. Summarizing, the literature on “trader group behaviour” has found little evidence that the positioning of specific trader groups has a systematic impact on oil prices. However, it has found that increased exposure of financial traders reduces price volatility.

Studying the relationship of crude oil prices and trading behaviour of fundamental vs. financial traders, we confirm that financial traders seem to reduce rather than to increase price volatility. This finding is robust to the point that even in periods of a sharp rise in crude oil prices, we cannot find a systematic impact of financial traders on the price level. However, we do not only confirm these findings, but also propose an explanation for it and this is where our paper starts adding to the literature: we find that it is important to distinguish between the impact on the price level and the impact on the slope (term structure) of prices. Our study suggests that financial traders do have a systematic impact, but simply not on the level but on the term premium of prices. The term premium is the price difference between crude oil of different (future delivery) dates. This impact is a flattening impact, i.e. financial investors seem to flatten the price curve which reduces the cost of time transformation. Although we do not find a systematic level impact of financial traders, we do find that impact for fundamental traders. This finding suggests that slope and level impact have to be studied separately. This is our first contribution.

In contrast to previous studies that typically proxy traders’ behaviour by employing the net position, our study suggests to use the relative long position for financial- and the relative short position for fundamental traders instead. Although the direction of the price impact is the same for both approaches, the significance of the impact is higher using our metrics. The suggestion of using these alternative metrics is our second contribution.

¹ Recently, the CFTC has started to raise the data on the monthly frequency.

Stimulated by the finding that financial traders arbitrate crude oil between different maturities, we were wondering whether they are also active in arbitrating crude oil between different markets. To this extend we studied the price difference between the Brent and the WTI market. Our findings confirmed our hypothesis: financial traders are indeed particularly active in eliminating price differences between Brent and WTI. For fundamental traders we do not find such an impact in our sample. The finding that the active arbitrage role of financials is not limited to maturities, but spans across markets is our third contribution. The remainder of the paper is structured as follows: Section 2 describes our approach and the data employed. Section 3 presents and discusses our findings. Section 4 is dedicated to robustness. Section 5 concludes.

2. Approach and Data

We follow a two-step approach: In the first step, we decompose the term structure of WTI crude oil and of the Brent-WTI spread (subsequently called “spread”) into a level-, a slope- and a curvature factor. We thus obtain time series of factor estimates. In the second step, we test whether the WTI- trading positions of the two trader groups affect the term structure’s level-, slope- or curvature.

2.1 Curve modeling

Rather than a single oil price, there exists a set of prices for oil for different delivery dates forming the oil price term structure. Instead of picking prices for arbitrary maturities, we opt for an approach that extracts the information contained in all maturities and at the same time reduces complexity. This approach employs a factor model that reduces the term structure of the oil price² into three factors that can be conveniently interpreted as the curve’s level, slope and curvature.

[Nelson, C. R. and A. F. Siegel \(1987\)](#) have been the first ones that successfully employed a factor model to describe a term structure, in their case the bond yield term structure. Since then, their idea has been quickly adopted by other researchers to study return predictability and extended to other types of term structures. The variant we use closely resembles the one introduced in Diebold, F. X. and C. Li (2006) that studies whether the extracted factors yield predictive power for bond yields. That the term structure of oil prices fulfils the (technical) conditions for a factor model of the Diebold-Li family has recently been shown by (Strange Hansen, et al., 2012)

The term-structure model is defined as follows:

$$y_t(\tau) = L_t + (1 - e^{-\lambda_t \tau}) S_t + \left(\frac{1 - e^{-\lambda_t \tau}}{\lambda_t} - \tau e^{-\lambda_t \tau} \right) C_t, \lambda_t > 0$$

where $y_t(\tau)$ is the price at date t of an oil future that matures τ months ahead of t , λ_t is a parameter of the polynomial, and L_t , S_t and C_t are the three factors of the polynomial. Note that this specification decomposes the term structure into maturity-dependent loadings and the factors L_t , S_t , C_t that affect all maturities.

² We only use the first eight maturities of the oil price curves [1M, 2M, 3M, 4M, 5M, 6M, 12M, 24M, M=month] as they constitute the liquid part of the curve. Thus we exclude the illiquid part of the curve consisting of 36M, 48M and 60M.

Figure 4 plots the factor loadings as functions of the maturity τ for $\lambda=0.15$. The polynomial is defined such that the factors yield nice interpretations: L_t can be interpreted as a level factor because it affects all maturities τ equally. The level measures the average price across all maturities. S_t corresponds to the slope factor because $(1 - e^{-\lambda_t \tau})$ increases monotonously in τ . Thus, distant maturities load heavily on S_t , mid-range maturities put medium weight on it, whereas close maturities put almost no weight on S_t . Thus, if the market is in backwardation, S_t will be negative, and it will be positive if the market is in contango. The slope factor measures the term premium of the futures' curve, i.e. the incremental discount/add-on for futures with longer maturities. C_t can be interpreted as a curvature factor because $(1 - e^{-\lambda_t \tau})/\lambda_t \tau - e^{-\lambda_t \tau}$ has a maximum somewhere on the positive domain and it converges to zero as τ either approach zero from above or if it grows big. Thus for positive C_t the term structure will typically be concave, whereas it tends to be convex for negative values of C_t . The curvature factor measures the change of the term premium.

Our polynomial differs from the one of Diebold, F. X. and C. Li (2006) in the loading for factor S_t . They use $(1 - e^{-\lambda_t \tau})/\lambda_t \tau$, which is downward sloping in τ and thus complicates interpretation. Another reason for our alternative polynomial is that we prefer a factor S_t , which is orthogonal to the very close maturities, over a factor S_t , which is orthogonal to the very far distances as in the case of Diebold, F. X. and C. Li (2006). We suspect that traders have a larger impact on the less liquid contracts with longer maturities.

L_t , S_t and C_t are estimated by regressing the cross-section of futures prices at t on a constant, $(1 - e^{-\lambda_t \tau})$, and $(1 - e^{-\lambda_t \tau})/\lambda_t \tau - e^{-\lambda_t \tau}$, where we fix $\lambda_t = 0.15$, which maximizes the loading of the curvature factor at $\tau = 12$ months, the most liquid maturity.

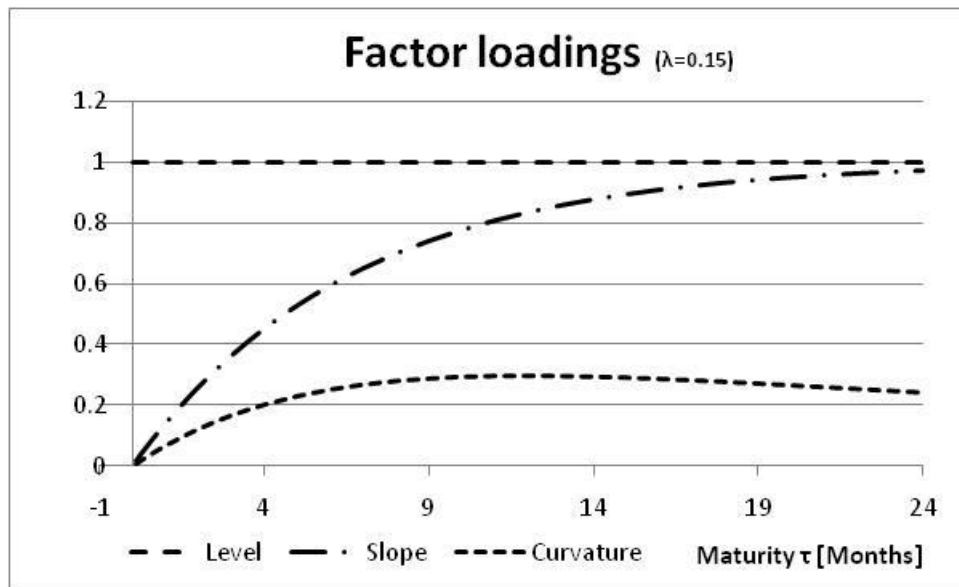


Figure 4 Loadings for factor decomposition of price term structure

The weekly price curves for WTI and Brent are obtained from the Chicago Board of Trade and cover the period from June 2000 through December 2013. We use the most liquid futures³, as they give a good representation of the full future curve reducing the risk of outliers. Exemplary fits of the factors for the WTI curve are plotted in [Figure 5](#).

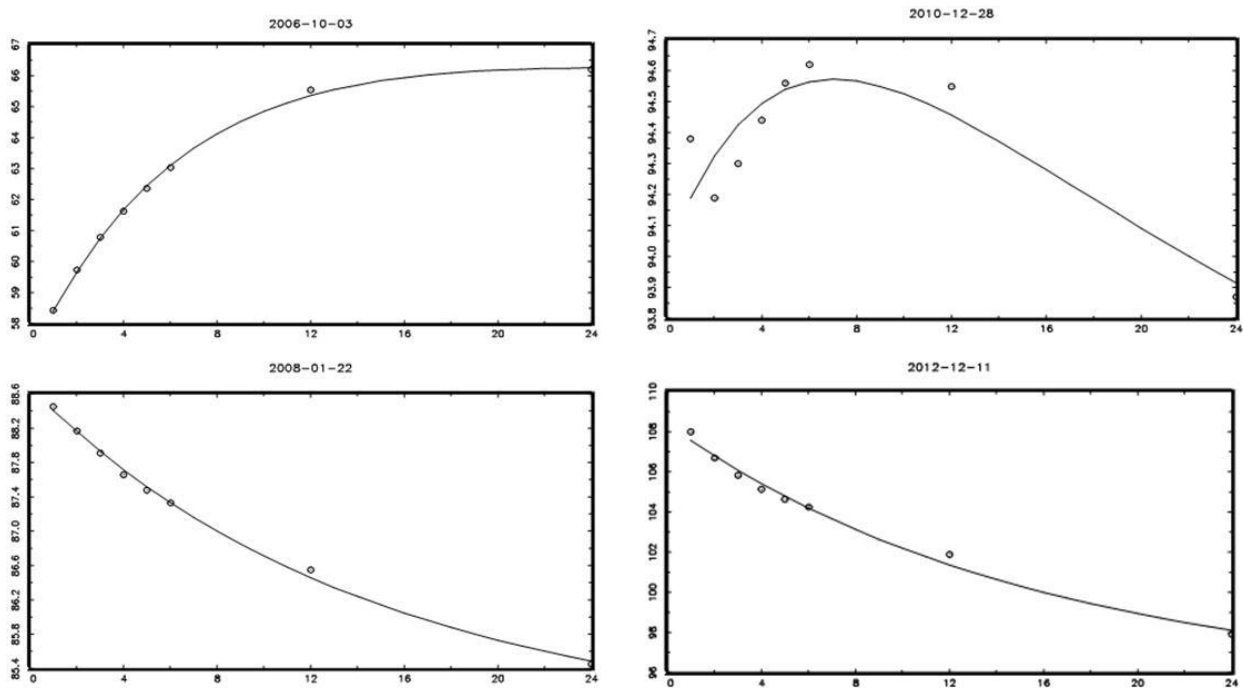


Figure 5 Exemplary fit of factor model for WTI-term structure for different curve scenarios

[Figure 5](#) suggests that the model describes the WTI-term structure well. Similar results that can be obtained from the authors upon request are obtained for the decomposition of the spread time series.

2.2 Regression Model

We use the factor estimates to study how the term structure is affected by trading positions of fundamental and financial traders. To model our weekly data, we employ auto-regressive distributed lag models similar to Diebold, F. X. and C. Li (2006) and Diebold, F. X., G. D. Rudebusch and B. S. Aruoba (2006):

³ We use the 1M, 2M, 3M, 4M, 5M, 6M, 12M and 24M future prices leaving out the futures for 36M, 48M and 60M [M=month].

$$\{L_t, S_t, C_t\} = b \cdot \{\text{Exposure Financial}_{t-1}, \text{Exposure Fundamentals}_{t-1}, \} \\ + a_0 + a_1 \cdot L_{t-1}^{\text{WTI}} + a_2 \cdot S_{t-1}^{\text{WTI}} + a_3 \cdot C_{t-1}^{\text{WTI}} \\ + c_1 \cdot \text{Stocks}_{t-1}^{\text{WTI, Cushing}} + c_2 \cdot \text{Freight Rate}_{t-1}^{\text{Arab. Gulf US-UK}} + c_3 \cdot \text{Market Liquidity}_{t-1} \\ + \varepsilon_t$$

Specifically, in separate regressions, we regress either the level-, slope- or curvature factor⁴ of either the WTI futures curve or the Brent-WTI spread term structure on the exposure of either fundamental traders (“COT”-Fund) or financial traders (“COT”-Fin).

This part of the regression model is central to our analysis. To measure the exposure of financial and fundamental traders, we use data from the weekly Disaggregate Commitment of Traders Report of the U.S. Commodity Futures Trading Commission (“CFTC”) that records the positions of several groups of traders.⁵ We classify as fundamental traders positions that are categorized by the CFTC as producers, merchants, processor, and users. As financial traders we classify the positions attributed to swap dealers⁶ and managed money⁷. Motivated by Keynes’ hedging pressure theory, we measure the exposure of financials as the share of their long-side open interest in the total long-side open interest, and the exposure of fundamental traders as the share of their short-side open interest in total short-side open. Our choice is empirically backed by the observation of (Cheng, et al., 2012) who document that fundamental traders are mainly positioned “short” and financial traders are mainly positioned “long”.

Moreover, in each regression equation, we include lags of the three term structure factors. We thus control for autoregressive dynamics in the factors, and also for changes in the futures curve that can be anticipated from other aspects of its shape. Beyond these variables, we include several controls to avoid omitted variable bias: The change in the storage volume of WTI crude oil in Cushing, transportation cost measured by the freight rate for a Barrel of Oil from the Arab-Gulf to the US, and a proxy for market liquidity:

$$\text{Market Liquidity}_{t-1} := \frac{\text{Last traded price}_{t-1} - \frac{(\text{Last bid quote}_{t-1} + \text{Last ask quote}_{t-1})}{2}}{\text{Last traded price}_{t-1}}$$

The market liquidity proxy attempts to measure excess demand or supply that might push the last traded price more to the last bid- or more to the last ask quote. If supply and demand are balanced, the last traded price equals the last mid-quote (= 0.5*(last bid + last

⁴ Given that the Augmented Dickey-Fuller test suggests that some of the estimated factors have a unit root – namely the level and slope of the WTI curve and the slope of the Brent-WTI spread – we have differenced the series before using them in the regression.

⁵ Specifically, we use the futures and options combined report

⁶ According to Irwin and Sanders (2012), this is an invalid proxy for commodity index fund exposure.

⁷ Buyuksahin and Harris (2011) argue this can be interpreted as hedge funds exposure.

ask)) and the indicator is zero. If there is an excess demand, the last traded price is pushed towards the last ask price and the indicator takes a positive value. In presence of excess supply, the last traded price is pushed towards the last bid-quote resulting in a negative indicator. The market liquidity proxy is computed on daily data for the closest to maturity contract. To obtain a weekly value, we have averaged across the daily observations.

Table 1 specifies the data employed and its sources. Due the limited availability of data on trader position, our estimation sample starts in June 2006 and ends in December 2012.

| Type of variable | Variable | Source | Period Start | Period End | Frequency |
|-----------------------------|-------------------------------|---|--------------------------|------------|-----------|
| Variable to test hypotheses | WTI Commitments of Trade | U.S. Commodity Futures Trading Commission | 13/6/2006 | 31/12/2012 | Weekly |
| Control variables | Freight Rate, Arab.Gulf-US/UK | Bloomberg | 07/05/1992 | | |
| | Stock, Cushing | Energy Information Administration (EIA) | 09/04/2004 | | |
| | Liquidity | Composite index on futures prices | Like WTI - future prices | | |

Table 1 Data and data sources

2.3 Sample definitions

Our full sample spans from June 2006 until December 2012 comprising 329 weekly price curves. To improve our understanding of the impact of trader exposure on the term structure, we also consider two sub-samples. Specifically, we consider the episode of the WTI-price rally (“Sharp WTI-rise”, from January 2007 until July 2008, 81 weeks) visible from [Figure 6](#), and a sub-sample in which the Brent-WTI spread started to diverge (“Diverging Spread”, from April 2011 until December 2012, 105 weeks), see [Figure 7](#).



Figure 6: 1 Month-WTI price evolution

If financial investors are responsible for sharp price movements, we hypothesize that this should be especially detectable in these exceptional periods.

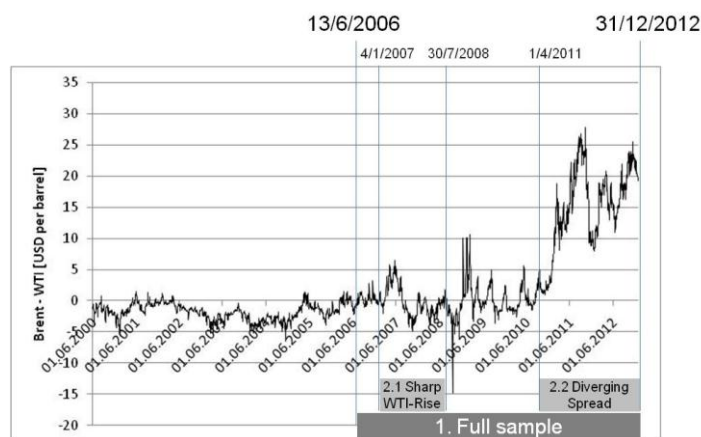


Figure 7: 1 Month - Brent-WTI Spread evolution

Analogously to WTI, we study the three periods “Full sample”, “Sharp WTI-rise” and “Diverging Spread”.

3. Results

3.1 WTI

Table 2 summarizes our regression results for WTI crude oil futures curve.

In particular, (***/**/*: significant at 1%/5%/10% level).

| 1. Full Sample | No | Type | R ² | b ^{COT} | c ^{FR} | c ^{Stock} | c ^{Liqui} | a _{DL} ^{1st} | a _{DL} ^{2nd} | a ^{Yt-1} |
|--------------------|----|------|----------------|------------------|-----------------|--------------------|--------------------|--------------------------------|--------------------------------|-------------------|
| 1. WTI - Level | a | Fund | 0.03 | 43.3** | -0.3 | -12.2* | -40.6 | 0.0 | 0.0 | -0.0 |
| | b | Fin | 0.02 | -1.4 | -0.3 | -10.9 | -46.2 | 0.0 | 0.0 | -0.0 |
| 2. WTI - Slope | a | Fund | 0.05 | 10.5 | 0.2 | 8.6** | 110.7 | 0.0 | 0.0** | -0.1 |
| | b | Fin | 0.06 | -26.2** | 0.2 | 8.7** | 111.5 | 0.0 | 0.0** | -0.0 |
| 3. WTI - Curvature | a | Fund | 0.90 | -27.8 | -0.2 | -0.4 | -181.4 | 0.2 | 0.1 | 0.9*** |
| | b | Fin | 0.90 | 16.8 | -0.2 | -1.1 | -179.2 | 0.2 | 0.1 | 0.9*** |

Table 2 Results for the WTI regressions : we regress the extracted level-, slope- and curvature factor on the exposure of (a) fundamental and (b) financial traders summing up to six regressions. The regressions are numbered: “1.” for the level-, “2.” for the slope- and “3.” for the curvature regressions. Column-wise, we report R² as well as the coefficients for the exposure variable (“b^{COT}”), those for the control variables (Freight rate: “c^{FR}”, Stock in Cushing: “c^{Stock}”, Market liquidity: “c^{Liqui}”) and the auxiliary variables (the other two factors: “a_{DL}^{1st}”, “a_{DL}^{2nd}”, lagged explained variable: “a^{Yt-1}”). As explained in section 2.2, the exposure for financial traders is measured as their share on all short positions whereas the exposure for fundamental traders is measured as their share on all long positions. All coefficient are reported with their values and their significance levels

(***/**/*: significant at 1%/ 5%/ 10% level)

In regression model 1.b - contrary to public opinion, but in line with most of the literature - we find no impact of the exposure of financial traders on the level of the WTI futures curve. This result is robust to alternative definitions of the exposure of financial traders (see section 4).

Those that do seem to have an impact on the level are fundamental traders: regression 1a suggests that the relative short open Interest of fundamental traders one week ahead has a significant positive impact (+43.3**, regression 1.1a) on the WTI-price level. However the sign is surprising. An increase of the relative fundamental short position (e.g. selling) of 1% leads to a 0.43% higher WTI level one week later. If we assume that “selling/ shortening” implies falling prices, we can infer that prices would have increased even more if fundamentals would not have sold. Thus, we confirm the dampening effect on volatility of financial traders previously reported in the literature. The dampening effect is even more pronounced as producers do not only sell new production (b^{COT}) but also stored production from their inventories (c^{Stock}: -12.2*, regression 1.a). One natural explanation is the behavior of producers, as they are driven by their production cost and are interested to increase selling at attractive prices to lock in a profit. This trading against market movements dampens volatility.

Considering the slope of regressions 2.a and 2.b, we find results that are diametrically opposed to the level regressions: Whereas the exposure of fundamental traders plays no role for the slope, the exposure of financial traders has a negative effect (-26**; regression 2b) on the slope. The result is intuitive as the position taking of financials is one of two possibilities to convert spot oil into future oil (“derivative term transformation”). Typically the financial sector is willing to accept lower “fees” for this service compared to physical holding (“physical term transformation”). As storing of oil is expensive, we find the significant positive impact of an increase in storage (8,7**, regression 2b). Again we find evidence for a positive impact of future markets on society. The activity of financial traders reduces the price of term transformation as they are not storing oil but just take the risk. Therefore they are willing to accept a carry below storage cost.

And finally, we do not find a significant impact of trading positions on the curvature factor.

3.1.1 The Oil Price Surge

Some have argued that the sharp rise of oil prices from January 2007 until July 2008 has at least to some extent been caused by (excessive) trading of speculative traders. Our previous results do not suggest a significant impact of financial traders on the level of the WTI-curve. Does the result change for this particular period, thus providing evidence for the “financial trader”-hypothesis? No, it does not as **Table 3** confirms. Our data suggests rather the opposite: fundamental traders kept having the same dampening impact on the price level (36,1**, 2.1a) as in the full sample, but the impact of the exposure of financials traders becomes insignificant. Thus, we do not find any evidence that trading of financials has driven the oil price up.

| 2. Sharp Rise | No | Type | R ² | b ^{COT} | c ^{FR} | c ^{Stock} | c ^{Liqui} | a _{DL} ^{1st} | a _{DL} ^{2nd} | a ^{Yt-1} |
|----------------------|----|------|----------------|------------------|-----------------|--------------------|--------------------|--------------------------------|--------------------------------|-------------------|
| 1. WTI - Level | a | Fund | 0.04 | 36.1** | -0.0 | 0.7 | -148.1 | 0.1 | 0.0 | -0.1 |
| | b | Fin | 0.03 | -23.1 | -0.0 | 1.7 | -158.5 | 0.1 | 0.0 | -0.1 |
| 2. WTI - Slope | a | Fund | 0.20 | -5.3 | -0.2 | 10.4 | 70.3 | 0.1 | 0.2*** | -0.1 |
| | b | Fin | 0.20 | 6.6 | -0.2 | 10.3 | 74.6 | 0.1 | 0.2*** | -0.1 |
| 3. WTI - Curvature | a | Fund | 0.59 | -33.2 | 0.9** | -11.0 | 469.1 | -0.0 | -0.2 | 0.7*** |
| | b | Fin | 0.59 | 10.1 | 0.9** | -12.1 | 469.0 | -0.0 | -0.2 | 0.7*** |

Table 3 Results for the WTI regressions
(Period: Sharp Rise) (***/**/*: significant at 1%/ 5%/ 10% level)

3.1.2 The Diverging Brent-WTI Spread

For a long time, the spread between Brent and WTI was small. It was based on differences in quality, transportation cost and time. This changed dramatically in 2011 as the spread ex-

ploded. The increase of oil production in the USA by fracking had a drastic impact on oil logistics in the USA. Historically, WTI crude is intermediated by pipeline, as the (large) imported portion of WTI was transported from the harbours to Cushing (Oklahoma) and subsequently distributed by pipelines to the US mainland. Due to new production technologies and geographical location the net demand of oil in this region now has turned to a net supply. The US and especially Canada have to use trains and trucks to transport oil as pipelines can be reversed only slowly. As this new infrastructure had to be set up quickly, transportation cost increased dramatically. Cushing, the central hub, could only receive oil from the coast but could not push it towards the coast, and so physical arbitrage between Brent and WTI became impossible. In the beginning of 2013 the pipeline to the harbours was reversed, however the transporting capacity is still fairly small.

The market for Brent, produced in the North Sea, is a tanker market, as the oil fields directly deliver to harbours. The fundamental difference in transportation possibilities separated the price of Brent and WTI, and production cost and tanker freight rates had hardly any importance for the price anymore.

It is not surprising that [Table 4](#) shows, that in this environment the fundamental traders lose their impact on the price level (regression 3.1a). Also the tanker freight rates have no impact on WTI anymore as on shore transportation cost is now the driving force for WTI.

| 3. Diverging S. | No | Type | R ² | b ^{COT} | c ^{FR} | c ^{Stock} | c ^{Liqui} | a _{DL} ^{1st} | a _{DL} ^{2nd} | a ^{Yt-1} |
|------------------------|----|------|----------------|------------------|-----------------|--------------------|--------------------|--------------------------------|--------------------------------|-------------------|
| 1. WTI - Level | a | Fund | 0.08 | 50.8 | -1.9 | 15.2 | 549.9** | 0.1 | 0.0 | -0.1 |
| | b | Fin | 0.08 | 37.3 | -2.1 | 14.3 | 525.2** | 0.1 | 0.0 | -0.1 |
| 2. WTI - Slope | a | Fund | 0.06 | -3.6 | 0.4 | -2.7 | -355.3** | -0.1 | 0.0 | -0.1 |
| | b | Fin | 0.08 | -51.9* | 0.7 | -2.6 | -352.3** | -0.0 | 0.0 | -0.1 |
| 3. WTI - Curvature | a | Fund | 0.88 | 39.4 | -3.4 | 19.9 | 528.9 | 0.2 | 0.3 | 0.97*** |
| | b | Fin | 0.88 | 85.4 | -3.8 | 19.2 | 508.3 | 0.1 | 0.3 | 0.97*** |

Table 4 Results for the WTI regressions
(Period: Diverging Spread) (***/**/*: significant at 1%/ 5%/ 10% level)

The impact of financial traders offering cheap time transformation is regained at the 10% level (-51.9*; regression 3.2.b) after the period of sharp price movements. As price volatility is reduced during this time period and physical transportation cost do not affect financial positioning this finding supports our view that financial traders are willing to offer low cost time transformation if the risk of price volatility is not excessive.

We now, for the first time, find a significant impact of market liquidity on both level and slope. Please recall that our liquidity variable is defined as the distance of the traded price to the last mid price. It seems that we capture the market imbalances due to the described transportation problems in the US. The expectation of a positive impact on the level is confirmed: it reflects the increased transportation cost which translates into higher prices. As

physical constraints and cost are likely to be reduced in the future the impact of our liquidity variable is negative.

3.2 Spread (Brent – WTI)

The spread measures the degree of market integration between Brent and WTI.⁸

As WTI trades at a discount due to transportation and infrastructure bottlenecks, the difference (Brent-WTI) is typically positive. To align the trading positions to this environment, we use relative long positions for both trader groups to study market integration. The control variables remain unchanged. **Figure 9** suggests that the spread curve is typically downward sloping, e.g. WTI- and Brent prices diverge by more for longer than for shorter maturities. With respect to curvature, **Figure 9** suggests that it is almost zero.

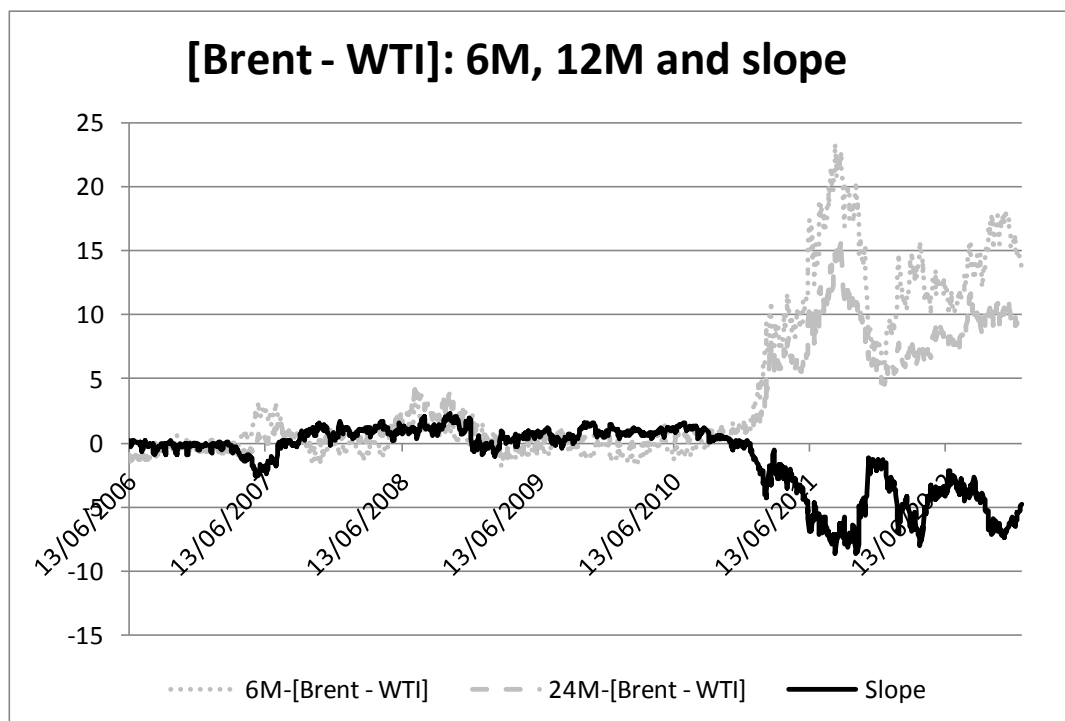


Figure 8 Evolution of 6M- and 24M-spreads as well as the evolution of the slope defined as [24M-6M].

⁸ Because only commitment data for WTI is available for the full length of the sample, we continued to use it. Therefore any spread interpretation should be seen from a WTI-point of view.

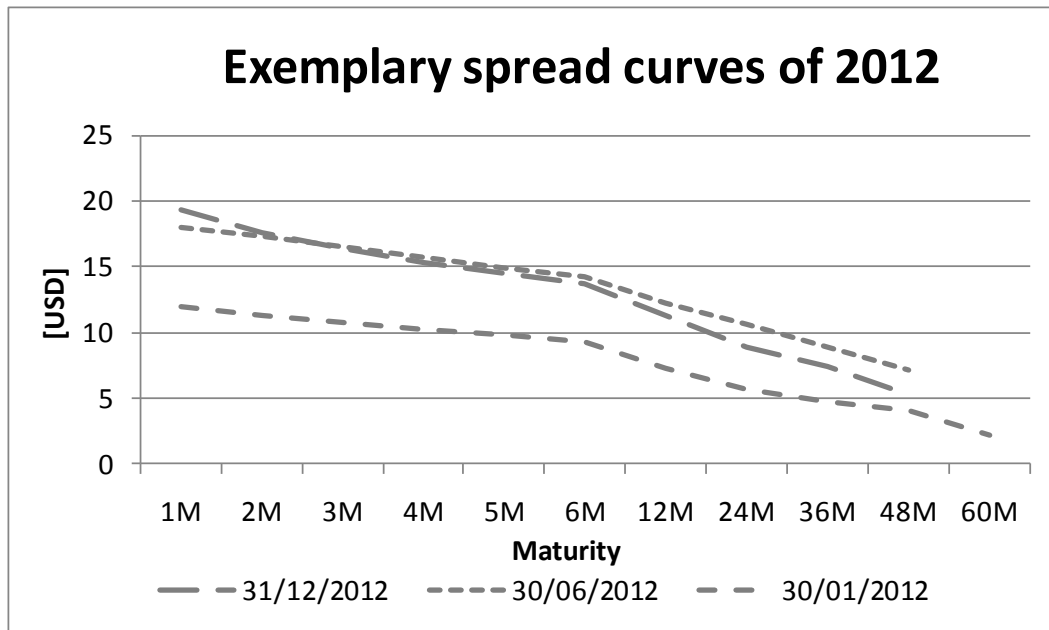


Figure 9 Spread (Brent – WTI)-curves for three individual days in 2012

Table 5 summarizes our results for the spread regressions.

| 4. Full Sample | No | Type | R ² | b ^{COT} | c ^{FR} | c ^{Stock} | c ^{Liqui} | a _{DL} ^{1st} | a _{DL} ^{2nd} | a ^{Yt-1} |
|-----------------------|----|------|----------------|------------------|-----------------|--------------------|--------------------|--------------------------------|--------------------------------|-------------------|
| 1. Spread - Level | a | Fund | 0.96 | 18.3 | -0.1** | 3.8 | -41.20 | -0.2*** | -0.0 | -0.97*** |
| | b | Fin | 0.96 | -18.9** | -0.1** | 4.2 | -41.60 | -0.2*** | -0.0 | -0.97*** |
| 2. Spread - Slope | a | Fund | 0.11 | -27.0* | 0.0 | -2.7 | 24.30 | 0.0 | -0.0*** | 0.2*** |
| | b | Fin | 0.12 | 23.5*** | 0.0 | -3.2 | 24.90 | 0.0 | -0.0*** | 0.2*** |
| 3. Spread - Curvature | a | Fund | 0.79 | 47.5** | 0.5** | -8.2 | -92.00 | -0.1*** | -0.0 | -0.8*** |
| | b | Fin | 0.79 | -21.0 | 0.5** | -7.4 | -93.70 | -0.1*** | -0.0 | -0.8*** |

Table 5 Results for the Spread regressions
(***/**/*: significant at 1%/ 5%/ 10% level)

Our results suggest that fundamentals are less important for market integration than financials: their systematic impact on the price level of an individual oil market like WTI disappears when studying the difference between markets. This finding suggests that they rather focus on local markets and less on relative price differences between markets.

By contrast, for financial traders we do find a significant impact on both spread level and -slope. As financial arbitrage integrates the markets, the spread reducing impact (-18.9**; regression 4.1 b) due to positioning against a spread widens. The positive impact of financials on the spread slope (+23.5***; regression 4.2b) is in line with the observations for WTI. Financial investors going long decreases the slope of WTI. With unchanged Brent this results in a flattening spread curve. Therefore, contrary to fundamental traders, they reduce

the slope leading to smaller price deviations in the future: Financial traders contribute to higher market integration.

Finally, we observe a significantly negative impact of freight rates on the spread level (-0.1**; 4.1a and b). The result is surprising at first sight, as higher transportation cost should lead to less market integration. However as Brent is a “tanker” market and WTI is a “pipe-line” market higher freight rates asymmetrically affect prices, resulting in a lower spread. We will come back to this point in the Section 3.2.2.

3.2.1 The Oil Price Surge

The time period of the sharp rise is marked by high price volatility. However, the sharp rise took place in both markets as the spread remained fairly small.

| 5. Sharp Rise | No | Type | R ² | b ^{COT} | c ^{FR} | c ^{Stock} | c ^{Liqui} | a _{DL} ^{1st} | a _{DL} ^{2nd} | a ^{Yt-1} |
|-----------------------|----|------|----------------|------------------|-----------------|--------------------|--------------------|--------------------------------|--------------------------------|-------------------|
| 1. Spread - Level | a | Fund | 0.76 | -11 | -0.0 | 1.9 | 50.9 | -0.3*** | 0.0 | -0.9*** |
| | b | Fin | 0.77 | 20.1** | -0.0 | 1.8 | 69.3 | -0.3*** | 0.0 | -0.9*** |
| 2. Spread - Slope | a | Fund | 0.24 | -4.7 | 0 | -2.0 | -5.6 | -0.1 | -0.1*** | 0.4*** |
| | b | Fin | 0.24 | -1 | 0 | -2.1 | -4.9 | -0.1* | -0.1*** | 0.4*** |
| 3. Spread - Curvature | a | Fund | 0.64 | 71.4*** | 0.0 | -2.8 | -329.7 | -0.2** | -0.4* | -0.8*** |
| | b | Fin | 0.65 | -79.4*** | 0.0 | -1.5 | -409.2 | -0.2** | -0.4 | -0.8*** |

Table 6 Results for the Spread regressions
(Period: Sharp rise, ***/**/*: significant at 1%/ 5%/ 10% level)

| 5. Sharp Rise | No | Type | R ² | b ^{COT} | c ^{FR} | c ^{Stock} | c ^{Liqui} | a _{DL} ^{1st} | a _{DL} ^{2nd} | a ^{Yt-1} |
|-----------------------|----|------|----------------|------------------|-----------------|--------------------|--------------------|--------------------------------|--------------------------------|-------------------|
| 1. Spread - Level | a | Fund | 0.76 | -11 | -0.0 | 1.9 | 50.9 | -0.3*** | 0.0 | -0.9*** |
| | b | Fin | 0.77 | 20.1** | -0.0 | 1.8 | 69.3 | -0.3*** | 0.0 | -0.9*** |
| 2. Spread - Slope | a | Fund | 0.24 | -4.7 | 0 | -2.0 | -5.6 | -0.1 | -0.1*** | 0.4*** |
| | b | Fin | 0.24 | -1 | 0 | -2.1 | -4.9 | -0.1* | -0.1*** | 0.4*** |
| 3. Spread - Curvature | a | Fund | 0.64 | 71.4*** | 0.0 | -2.8 | -329.7 | -0.2** | -0.4* | -0.8*** |
| | b | Fin | 0.65 | -79.4*** | 0.0 | -1.5 | -409.2 | -0.2** | -0.4 | -0.8*** |

Table 6 indicates that during this period (January 2007 – Jul 2008) fundamental traders do not have any systematic impact on the spread level nor do they have an impact on the slope. During this period, the absolute spread (and its slope) is close to zero. Thus, the absence of a systematic impact of fundamental traders is not surprising. For financial traders we do find a systematic impact on the level, however their position seems to increase the spread (20.1**; regression 5.1b). Their positioning in this market turmoil depends only on WTI pricing, not on the relative pricing of demand. Again curvature is reduced by fundamental traders (71.4***; regression 5.3a) however we find the opposite effect for financial traders (-79.4***; regression 5.3b).

During this sub period the focus of all traders was WTI or Brent but not the spread. Compared to the large movements in price, the small spread difference was not very attractive for arbitrage.

3.2.2 The Diverging Brent-WTI Spread

During this period (April 2011 – December 2012), WTI disconnected from Brent because of missing transportation possibilities which made physical arbitrage between the markets very expensive. Due to its transportation disadvantage, WTI traded at a large discount compared to Brent which reflects the increased market disintegration.

| 6. Diverging S. | No | Type | R ² | b ^{COT} | c ^{FR} | c ^{Stock} | c ^{Liqui} | a _{DL} ^{1st} | a _{DL} ^{2nd} | a ^{Yt-1} |
|-----------------------|----|------|----------------|------------------|-----------------|--------------------|--------------------|--------------------------------|--------------------------------|-------------------|
| 1. Spread - Level | a | Fund | 0.83 | 131.9*** | -1.9*** | 10.2 | -112.1 | -0.2 | -0.0 | -0.8*** |
| | b | Fin | 0.82 | -69.1*** | -2.3*** | 8.4 | -169.6 | -0.1 | -0.1** | -0.8*** |
| 2. Spread - Slope | a | Fund | 0.23 | -140.3*** | 1.6* | -14.6 | 68.4 | -0.1** | -0.0 | 0.2** |
| | b | Fin | 0.24 | 83.3*** | 1.9*** | -12.7 | 133.3 | -0.1** | 0.0 | 0.2* |
| 3. Spread - Curvature | a | Fund | 0.81 | 133.1 | 1.4 | 13.0 | -90.6 | -0.3* | -0.2 | -0.8*** |
| | b | Fin | 0.81 | -68.0 | 1.0 | 11.1 | -147.9 | -0.3* | -0.2 | -0.8*** |

Table 7 Results for the Spread regressions
(Period: Diverging spread, ***/**/*: significant at 1%/ 5%/ 10% level)

Again, we see the positive impact of financial traders, confirming the results of the full sample. As Table 7 suggests financial traders reduced the spread level (-69.1***, regression 6.1b) by financial arbitrage and reduce the slope of the spread curve (83.3***, regression 6.2.b). It is not surprising that financial arbitrage is more significant in an environment of large spreads, as larger spreads imply higher profit opportunities.

The impact of fundamental traders is significant but exhibits an opposite sign. As physical arbitrage is very expensive in the local markets, their long positions (131.8***; 6.1a) increase the spread and also increase future spreads (-140.3***; 6.2a).

Tanker transportation during this time period completely lost its importance for WTI, as the US market was driven by local bottlenecks. Our model captures the impact on Brent which is a tanker market: as Brent has to be transported by vessels an increase in freight rates makes Brent less attractive leading to lower Brent prices leaving WTI unchanged. Therefore the spread difference is reduced (-1.9*** 6.1a and -2.3***; 6.1b). The same argument holds for the future spreads (1,6*; 6.2 a and 1,9***; 6.2 b).

During the pipeline and infrastructure bottlenecks of WTI, financials again have a positive impact on market integration.

4. Robustness tests

To address the possibility that our choice of restricting the curve to the first eight future maturities ($\leq 24M$) could have been motivated by a poorer fit if we had included the full curve (including 36M, 48M and 60M), we present here exemplary fits of the factors for the full WTI-curve [1M,..., 60M].

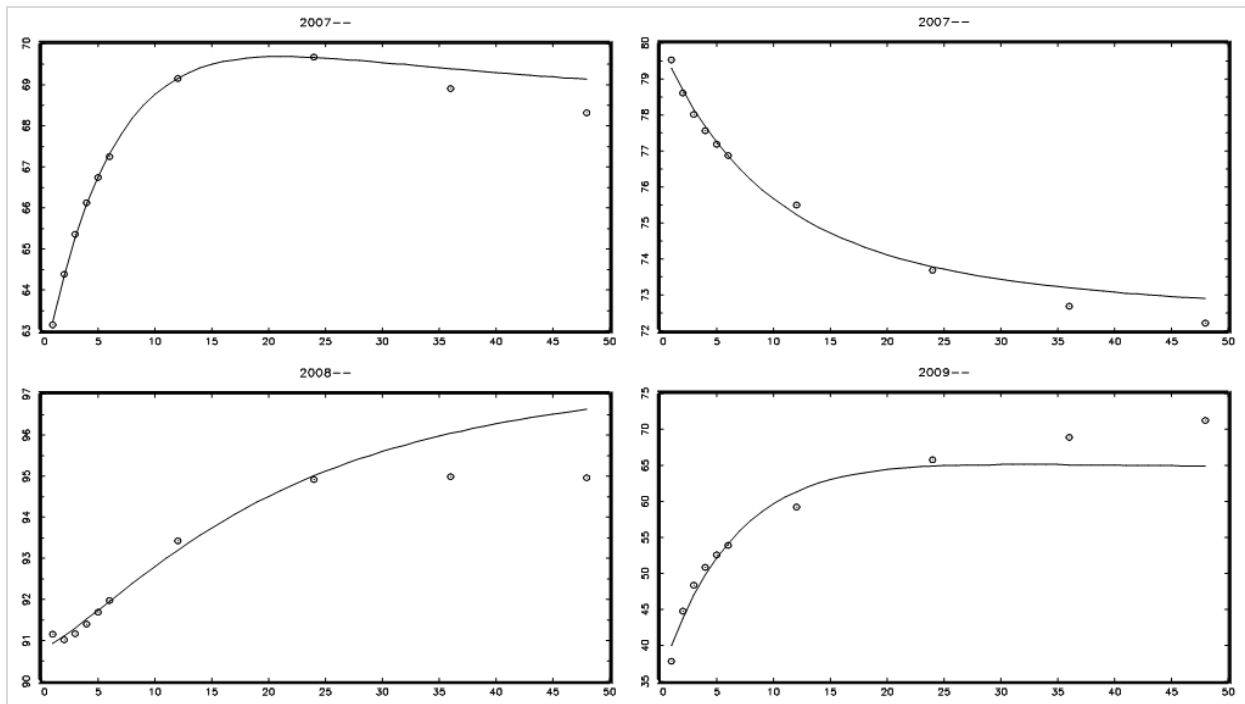


Figure 10 Exemplary fit of factor model for WTI-term structure for different curve scenarios, using all future maturities.

Figure 10 suggests that the factor model also covers future prices of longer maturities reasonably well. Longer maturities are not particularly off although the observation density is much lower (annual coverage) compared to the first 6 months (monthly coverage).

Furthermore, we consider the alternative definitions of trader exposures as listed in Table 8.

| No | Name | Definition |
|----|----------------------------------|--|
| 1 | Total Open interest | $Long+Short+2*Spreading$ ¹⁹ |
| 2 | Total Open interest <u>Share</u> | As a share of the total open interest across all trader groups (as a measure of the change in relative importance of the groups) |
| 3 | Net position | Net position of each trader group |
| 4 | Net position <u>Share</u> | Net position of each trader group as a share of total open interest |
| 5 | Spreading | Spreading position of financial trader groups |
| 6 | Spreading <u>Share</u> | Spreading position of fin. trader groups as a share of total open interest |

Table 8 Alternative variable definition

In all cases the relative definitions (... Share) led to better results as changes in the total amount of outstanding contracts seem to have no impact on prices.

| b^{COT} | Level | | Slope | |
|------------------------------|--------|-------|---------|---------|
| | Fund | Fin | Fund | Fin |
| Total Open interest | 2.6 | -4.6 | 5.5** | 6.9 |
| Total Open interest Share | 39.3* | -6.9 | 19.0 | -27.8* |
| Net position | 0 | 0 | 0 | 0 |
| Net position Share | -41.3 | 25.0 | 33.4143 | -23.1 |
| Spreading | #NA | -4.4 | #NA | 5.7 |
| Spreading Share | #NA | -28.8 | #NA | -11.3 |
| => Long Open Interest Share | 27.3 | -1.4 | 23.9 | -26.2** |
| => Short Open Interest Share | 43.3** | -12.6 | 10.5 | -23.8 |

Table 9 Coefficients of alternative exposure measures [Full sample]

During our observation period the number of oil contracts has always been large to ensure sufficient market liquidity, therefore we suggest to use relative definitions. None of the tested alternatives contradicted our findings; however they typically were less significant as Table 9 suggests. One of the key findings, namely that financial traders do not have a significant impact on the price level of oil, is confirmed by all alternative measures.

In the literature, relative net positions are frequently used to measure exposure. As we use relative short- or relative long-positions, we find it informative to benchmark our results

⁹ If available, Spreading “is the opposite of open interest ”as it measures the volume that each non-commercial trader holds in combined-long and combined-short positions In this spirit, it could also be called ‘closed interest’.

against the results one would have obtained using net positions. Table 10 summarizes the results using our approach, Table 11 shows the results using net positions instead.

| b^{COT} | WTI - curve | | | | | | Spread (Brent - WTI) – curve | | | | | |
|-----------|-------------|-------|------------|-------|--------------|-------|------------------------------|-------|------------|-------|--------------|---------|
| | Full sample | | Sharp rise | | Diverging S. | | Full sample | | Sharp rise | | Diverging S. | |
| | Level | Slope | Level | Slope | Level | Slope | Level | Slope | Level | Slope | Level | Slope |
| Fund | 43** | | 36** | | | | | -27** | | | 132*** | -140*** |
| Fin | | -26** | | | | -52* | -19** | 24*** | 20** | | -70*** | 83*** |

Table 10 Result summary [position coefficient b^{COT}] using relative long/short positions

| b^{COT} | WTI - curve | | | | | | Spread (Brent - WTI) – curve | | | | | |
|-----------|-------------|-------|------------|-------|--------------|-------|------------------------------|-------|------------|-------|--------------|---------|
| | Full sample | | Sharp rise | | Diverging S. | | Full sample | | Sharp rise | | Diverging S. | |
| | Level | Slope | Level | Slope | Level | Slope | Level | Slope | Level | Slope | Level | Slope |
| Fund | -41 | | -25 | | | | | -39** | | | 176*** | -158*** |
| Fin | | -23 | | | | -2 | -21 | 31** | 17 | | -78** | 77** |

Table 11 Result summary [position coefficient b^{COT}] using relative net positions

Where relative long/short-positions are not significant, relative net positions are not significant either. Since we define our variables as shares, they are always positive. Tables 8 and 9 show that the signs of all long positions¹⁰ are the same as those of net positions. Since the relative short position we used for WTI-fundamentals is a positive number, the net position should have the opposite sign. This is confirmed. Our results therefore reveal the same impact as if measured with relative net positions; but our position measure yields more significant coefficients.

¹⁰ We used long positions for all spread results and for WTI-financials.

5. Conclusion

This paper has studied the extent to which the trading positions of fundamental or financial traders affect crude oil prices. In contrast to the previous literature, we use a modified approach by decomposing the WTI futures curve and the Brent-WTI-spread curve into three factors: a level-, a slope- and a curvature factor. In a second step, we regress these factors on time series of trading positions of either fundamental or financial traders lagged by one week, controlling for market liquidity, storage and transportation cost. In contrast to the standard approach of using net positions as an exposure measure, we propose to use the relative long positions for financial and the relative short positions for fundamental traders instead, leading to more significant results.

Studying the WTI futures curve, we find that fundamental traders significantly affect the price level but not the slope, whereas financial traders significantly affect the slope but not the price level. The sign of the impact suggests that trading reduces volatility: fundamental traders smooth the price level whereas financial traders reduce the cost for time transformation. Both trading activities therefore yield positive effects for society.

To assess whether our results also hold in periods of remarkably high price movements, we limit the sample to the periods of a sharp rise in WTI prices (January 2007 until July 2008) and of an increasing spread between WTI and Brent (April 2011 until December 2012).

For the period of the WTI-price rally, we find a weaker impact of financial traders on slope than for the complete sample and still no significant impact on the level of the WTI curve. This finding contradicts claims those that suspected especially financial traders to be the driving force behind this price rally. Although the impact of financial traders weakens, the smoothing impact of fundamental traders on the level is still present during the price rally. We suggest that in time periods with substantial price risk financial traders are less willing to supply the market with time transformation. On the other hand fundamental traders are more driven by production cost; therefore higher price volatility does not change their behaviour. In the second sub-period of a diverging spread, we find fundamental traders losing their significant impact on the price level due to the transportation bottleneck of WTI. Financial traders re-gain their impact as financial positioning is more attractive implying again a reduction in the cost of time transformation.

Studying the spread between Brent and WTI, we find evidence that financial traders are more important for market integration than fundamental traders. They typically reduce the price differences between the two markets. They lost this function during the WTI-price rally when the potential gain (the spread) was small compared to the large price change.

Our contribution to the literature is threefold. There is first the suggestion that studies on the impact of trader groups should distinguish between a level and a slope impact. We find a disjoint impact of traders (fundamental traders: level, financial traders: slope). Without the distinction between level and slope, researchers are likely to obtain mixed and non-conclusive evidence. Second, our results suggest that using the relative short-/ long positions of traders instead of their net position leads to more significant results (but the same signs). Our third contribution is that the active arbitrage role of financials is not limited to maturities, but extends to markets.

Since the impact of both trader groups in the past has been positive for society, future research will address the question whether the financial crisis has reduced the impact of financial and fundamental traders. Markets are currently hit by a regulatory shock, as capital-, process- and collateral requirements for bilaterally settled contracts have substantially increased, due to Basel III and EMIR/ Dodd-Frank. Whether this development has reduced the positive effects of oil future trading for the society would be a natural extension of our study.

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