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Do speculators drive crude oil prices?

Dispersion in beliefs as a price determinant

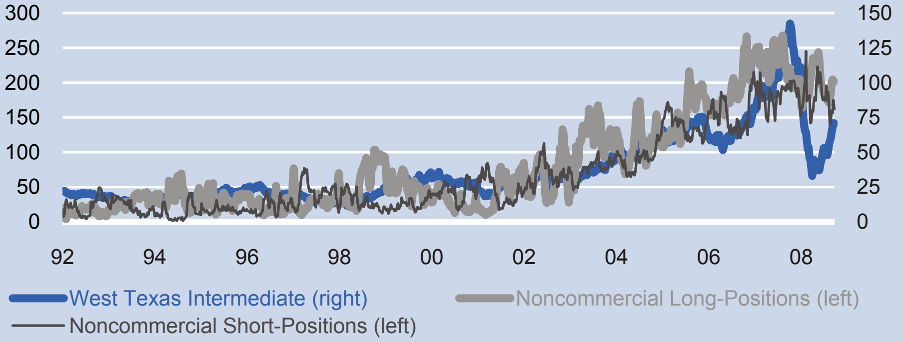
CFTC reassesses the role of speculators. Before Gary Gensler became its chairman, the US Commodity Futures Trading Commission (CFTC) held the view that speculators had little influence on the price of crude oil, but since then a reassessment has been taking place. The crude oil market is particularly suitable for an analysis of the role of speculative trading due to the enormous importance of oil to the global economy as a commodity and the high liquidity of its futures market.

The influence of speculation can be substantiated. This article measures speculator activity on the basis of variables contained in the weekly CFTC market reports and analyses speculator influence on crude oil prices and crude oil price volatility using econometric procedures. The results suggest an influence of speculators' dispersion in beliefs on both crude oil prices and price volatility. Limiting the data basis until 2006 leads to results roughly consistent with those based on the current data set. The structural impact of speculators on the crude oil market thus does not seem to vary significantly.

Results suggest where regulatory reform should be targeted. It is not the activities of speculators themselves, but speculators' dispersion in beliefs that drives crude oil prices – as this paper shows. For this reason the findings of the CFTC also suggest how regulation could be targeted.

Noncommercial Positions (weekly)

in 1000, USD



Sources: CFTC, DB Research

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Dispersion in beliefs among speculators as a determinant of crude oil prices

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Abstract

This article discusses the influence of speculators in the futures market on crude oil prices. The results suggest the dispersion in beliefs influences both crude oil prices and price volatility.

JEL Classification: C51, G12, G18, Q41
Keywords: Crude oil market, futures market, speculation

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1 The CFTC and the role of speculators

With Gary Gensler taking office as chairman of the Commodity Futures Trading Commission (CFTC) in May 2009, its assessment of the role of speculators changed. In July 2008, i.e. when the commodity boom was at its peak, the CFTC still held the view that there was not sufficient evidence[1] of the influence of speculators on commodity prices and even attributed to them the market-serving functions from the Keynes-Kaldor textbook.[2] These conclusions were already controversial at that time as not only had the price of crude oil multiplied in the space of a few years but the volume of index funds investing in commodities had also risen almost 20-fold.[3] The reappraisal of the CFTC prompted us to analyse the influence of speculators on the crude oil market in this paper. Furthermore, instructions for action by the CFTC can be derived from the results we present. The crude oil market is particularly suitable for analysing the role of speculators. First, crude oil is particularly important for the development of economies. Second, the NYMEX crude oil futures market is the largest and most liquid futures market worldwide, which makes it particularly attractive for speculators. Third, crude oil prices are highly volatile, and the price of crude rose more than tenfold between 1998 and 2008. The CFTC now shares OPEC's view, which has already highlighted the influence of speculators for years. For example, Adnan Shihab-Eldin, director of OPEC's Research Division, stated back in 2005: "Today, and especially with non-fundamental factors – such as speculation in oil futures markets – playing such a critical role in oil price determination, we feel that leaving such a sensitive trading environment as the oil market to its own devices would surely be a recipe for disaster, both for producers and consumers. Hence our continued commitment to ensuring market stability."[4] Many other similarly pointed quotes from OPEC officials exist or can be found in OPEC reports. The fact that no attention was paid to OPEC's views hardly comes as a surprise. However, the disregard for a BIS study (2004) and the evidence of a correlation between speculation and the price of crude oil is all the more surprising. In addition, some articles published by academics have discussed speculators' influence on crude oil prices and were apparently deemed to be irrelevant by the CFTC (Pindyck 2001, Hamilton 2008).

Following these introductory remarks, theories on speculators' influence on financial markets are described in Section 2. Section 3 characterises the crude oil market. Section 4 provides descriptions of the variables used for the econometric estimates and regression results. Section 5 contains the regression results on price volatility. Section 6 reports the summary and evaluation of the results.

2 Theories on speculators' influence on financial markets

Keynes (1930) and Kaldor (1939) regarded speculators as market-stabilising forces allowing other traders to engage in hedging activity. According to the Keynes-Kaldor theorem, the market positions of speculators only incur average losses, however, so that they do not affect the long-term market development. Traders who actually intend to use the commodity traded therefore profit from speculators due to higher market liquidity and additional profit potential.

[1] Although consistently almost positive correlations are found between net non-commercial positions and the oil price between early 2003 and 2008, in the subsequent Granger causality analysis, the period is extended to 2000, and the results suggest that prices drive non-commercial positions and not vice-versa.
[2] "As such, speculators serve important market functions – immediacy of execution, liquidity, and information aggregation." CFTC (2008b).
[3] See Masters (2008).
[4] http://www.opec.org/opecna/Speeches/2005/CosmoVie.htm (24 Nov 2009).

Some recent financial-market models show how speculators may have market influence also in the long term. While traders who want to buy the physical commodity trade close to fair value, speculators find it difficult to distinguish between the market price and the fair value. Thus, they continue their trading activity even if a large gap has opened up between market prices and fundamentally justified prices. Speculators' dispersion in beliefs thus increases price volatility. Second-round effects from increased price volatility may put additional upward pressure on volatility. First, the market as a result of the already higher price volatility and the findings of regular persistence of volatility persistence measures has become even more attractive for speculators. Second, with every additional speculator in the market, the market influence of traders, interested in using the physical commodity, declines. A small number of these traders may then become the plaything of speculators as traders, due to an increasing number of speculators, try to avoid the increasing risk of losses incurred by positions against the market. In the short run all speculators may profit from rising prices. Yet, in the long run prices might burst and this market environment either comes to an end or is renewed by new speculators being out for easy money. If a market is large and liquid and traded products are scarce and important for the production process, speculators may be repeatedly attracted such that market prices may differ from fair prices considerably and regularly. (Harrison and Kreps 1978, DeLong et al. 1990, Harris and Raviv 1993, Shalen 1993, Odean 1998, Daniel et al. 2001, Banerjee 2008, Cao and Ou-Yang 2009).

The following null hypotheses can be deduced from these models:

Hypothesis 1: The dispersion in beliefs of speculators has no influence on crude oil prices.

Hypothesis 2: The dispersion in beliefs of speculators has no influence on the volatility of crude oil prices.

3 Characterisation of the crude oil market

A large variety of fundamental market forces – OPEC, oil discoveries, limited production and refinery capacities, new technologies, the increase in demand for oil in the emerging markets, the building-up and drawing down of oil inventories, catastrophic weather and not least political unrest and wars – have an impact on the development of oil prices. Developing a simple model that is simple but which also factors in all relevant market forces is therefore a mammoth task. This holds all the more since both demand and supply are relatively price inelastic in the short term. The more price inelastic a supply curve, the more market prices are affected by a shift in the demand curve. Thus, even without the impact of speculators, small fundamental changes in market factors may cause relatively large changes in prices.

Such major market uncertainties about fair value provide the ideal environment for successful investing by speculators. If speculators, such as hedge funds, also only invest outside capital they can profit from market fluctuations and risky investment strategies without bearing the risk of personal wealth losses.[5] For this purpose, speculators typically use the futures market to avoid the physical ownership of commodities by squaring market positions. Due to their high liquidity, the favourite vehicles for investment are NYMEX crude oil contracts whose underlying is 1,000 barrels of West Texas Intermediate (WTI) reference crude.

[5] A case in point is the fund of Amaranth Advisors LLC which initially generated high returns by making risky bets. In 2006, the fund had USD 9 bn under management before even riskier bets incurred losses of USD 6 bn. See Economist "A big hedge fund in trouble", Sep 21, 2006.

CFTC itemises the long and short positions of all market participants in weekly reports. Long and short contracts also reflect expectations on future oil prices. Traders who expect rising prices go long while traders expecting falling prices build up short positions. Furthermore, a distinction is made between commercial and non-commercial futures traders. Non-commercials, despite some difficulties in drawing a distinction[6] are above all hedge funds and other market participants who might be regarded as speculators. CFTC considers, for example, speculators who execute their trading via swap transactions to be commercial traders, so that our variables introduced below probably underestimate speculators' influence. In line with the description of the futures market, the hypotheses formulated above may be operationalised as follows, whereby a rejection of the null hypotheses suggests that speculators do influence the price of crude oil.

Hypothesis 1: In the futures market, the number of long positions taken by non-commercials does not have a positive influence on the *price* of WTI crude in the spot market and the number of short positions taken by non-commercials does not have a negative influence on the *price* of WTI crude in the spot market.

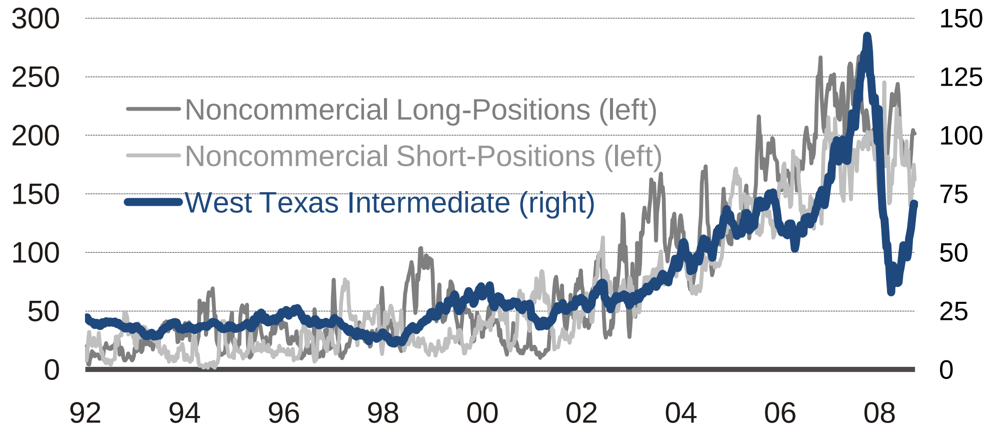
Hypothesis 2: In the futures market, the number of long positions taken by non-commercials does not have a positive influence on the *volatility* of WTI in the spot market and the number of short positions taken by non-commercials does not have a negative influence on the *volatility* of WTI in the spot market.

4 Impact of speculators on price development

Due to major uncertainty about the macroeconomic determinants of the crude oil market, we shall not construct a model that replicates the data generating process but will analyse the impact of speculators on the development of prices using simple specifications. The testing of the hypotheses is based on both weekly and monthly data (*w* specifications and *m* specifications in estimation tables). Figure 1 shows the weekly price development of WTI and the turnover of both long and short non-commercial positions in the futures market.

Figure 1: Noncommercial Positionen (Weekly)

in 1000, USD



Sources: CFTC, DB Research

6 See CFTC (2008a), Büyüksahin (2008).

All three time series are initially relatively uniform and rise sharply at the beginning of the new century, indicating a new economic environment. The regressions therefore consider only data from after the turn of the millennium. Furthermore, all statistics are calculated for the entire survey period until 2009 and for the period prior to the financial crisis (*p* specifications in estimation tables) until July 2006. In addition, non-commercial long positions are designated as *FutLong* variables and non-commercial short positions similarly as *FutShort*.

Dispersion of beliefs in the nonstationary world

Standard unit root tests do not reject the nonstationary hypotheses for all three variables. Tests on the number of cointegration ranks are documented in Table 1 and also confirm the existence of at least one cointegration rank.

Table 1 (W=weekly data): number of cointegration ranks
LR Johansen Trace Test, variables: WTI, FutLong, FutShort

Ranking	**(W1)**	**(W2)**	**(W1P)**	**(W2P)**
0	55.28**	47.22**	34.10*	35.11*
1	11.12	15.66*	9.70	9.11
2	1.36	11.32	0.02	0.58
N	491	482	341	338
#Lags	2	11	1	4
Period	Jan 00 - Jul 09	Jan 00 - Jul 09	Jan 00 - Jul 06	Jan 00 - Jul 06

Constants and a trend are included in all specifications, whereas the cointegration relationship does not include a trend but a constant. AIC and BIC determine the optimum lag length. * at the 1% significance level, ** at the 5% significance level.

Table 1 (M=monthly data): Number of cointegration ranks
LR Johansen Trace Test variables: WTI, FutLong, FutShort

Rang	**(M1)**	**(M2)**	**(M1P)**	**(M2P)**
0	54.07**	33.84**	32.53*	32.88**
1	15.05	11.40	12.45	15.55*
2	0.63	0.69	1.11	1.87
N	111	107	73	69
#Lags	2	6	4	8
Period	Jan 00 - Jul 09	Jan 00 - Jul 09	Jan 00 - Jul 06	Jan 00 - Jul 06

Constants and a trend are considered in all specifications, whereas the cointegration relationship does not include a trend but a constant. AIC and BIC determine the optimum lag length. * at the 1% significance level, ** at the 5% significance level.

The cointegration relationship is determined using the Johansen error correction model. The results of the rank test are used to impute a rank for calculating the cointegration equation. For the calculation the coefficient of WTI is standardised to 1.

$$\mathrm{WTI}_t - \alpha_1 \mathrm{FutLong}_t - \alpha_2 \mathrm{FutShort}_t = \mathrm{ec}_t\,,$$

where the coefficient of WTI_t is standardised to 1, α_1 and α_2 are the coefficients of the cointegration equation and ec_t is the error correction term.

Table 2 (W): Standardised variable in cointegration relationship: WTI

	(W1)	**(W2)**	**(W1P)**	**(W2P)**
FutLong	0.154**	-0.236**	0.143**	0.078**
	(0.024)	(0.085)	(0.032)	(0.018)
FutShort	-0.196**	-0.122	-0.187**	-0.122**
	(0.030)	(0.109)	(0.042)	(0.023)
Adj. Coeff.	0.00023	-0.04262**	0.00107	0.00293
	(0.0002)	(0.00808)	(0.00138)	(0.00259)
N	491	482	341	338
#Lags	2	11	1	4
Period	Jan 00 - Jul 09	Jan 00 - Jul 09	Jan 00 - Jul 06	Jan 00 - Jul 06

Constants and a trend are considered in all specifications, whereas the cointegration relationship does not include a trend but a constant. AIC and BIC determine the optimum lag length. * at the 1% significance level, ** at the 5% significance level.

Table 2 (M): Standardised variable in cointegration relationship: WTI

	(M1)	**(M2)**	**(M1P)**	**(M2P)**
FutLong	-0.189**	-0.259**	-0.830**	-0.410**
	(0.075)	(0.112)	(0.197)	(0.167)
FutShort	-0.182*	-0.770**	0.574**	-0.232
	(0.095)	(0.145)	(0.215)	(0.180)
Adj. Coeff.	-0.178**	-0.095**	-0.0065	-0.114**
	(0.0321)	(0.0432)	(0.0018)	(0.038)
N	114	114	73	69
#Lags	2	6	4	8
Period	Jan 00 - Jul 09	Jan 00 - Jul 09	Jan 00 - Jul 06	Jan 00 - Jul 06

Constants and a trend are considered in all specifications, whereas the cointegrating relationship does not include a trend but a constant. AIC and BIC determine the optimum lag length. * at the 1% significance level, ** at the 5% significance level.

The results do not document any clear correlation for a stable cointegration relationship. There are differences between both the signs and significance levels of the variables. There are also differing results both within the entire sample and within the sample until 2006.

If all three bivariate cointegration relationships are investigated, cointegration can be found between FutLong and FutShort. The trace statistic of 35.94^{**} (critical value at the 5% significance level: 15.49) definitely refutes the nonexistence of a cointegration rank and just as definitely cannot refute the first cointegration rank 1.88^{**} (critical value at the 5% significance level: 3.84). The estimated cointegration equation (standard error in brackets)

$$\text{FutLong}_t - 1{,}26^{**}\,(0{,}10)\,\text{FutShort}_t = ec_t$$

is both statistically significant and economically interpretable. When the number of long contracts increases, the number of short contracts also increases. The adjustment coefficient in this estimation of -0.04** (0.01) is also significant and negative – in contrast to the trivariate system – through which deviations from the long-run trend are corrected. The existing cointegration relationship between FutLong and FutShort is presumably also the cause of the detected cointegration rank in the trivariate system with WTI, FutLong and FutShort. This presumption is also confirmed by the rejection of all rank hypotheses in both bivariate cointegration analyses between WTI and FutLong abd between WTI and FutShort.[7]

Dispersion of beliefs in the stationary world

The statistical results in the preceding section combined with the theoretical considerations about deriving the hypotheses suggest that the following approach is appropriate. In order to measure the dispersion of beliefs among speculators regarding the oil price the following equation is estimated:

$$\Delta\text{WTI}_t = \beta_0 + \beta_1\text{NetLong}_t + \text{u}_t \quad (1)$$

where NetLong is the difference between FutLong and FutShort. NetLong is a stationary variable in accordance with the bivariate cointegrating equation shown above. Table 3 documents a robust and highly significant relationship both for the entire sample and the 2006 sample as well as for both the weekly and monthly data.

[7] For bivariate cointegration the Engle-Granger method has better small sample properties (Gonzalo and Lee 1998). The results of the Engle-Granger method however confirm the results of the Johansen test. We therefore continue using the Johansen method in this case.

Table 3: OLS regression dependent variable: ΔWTI

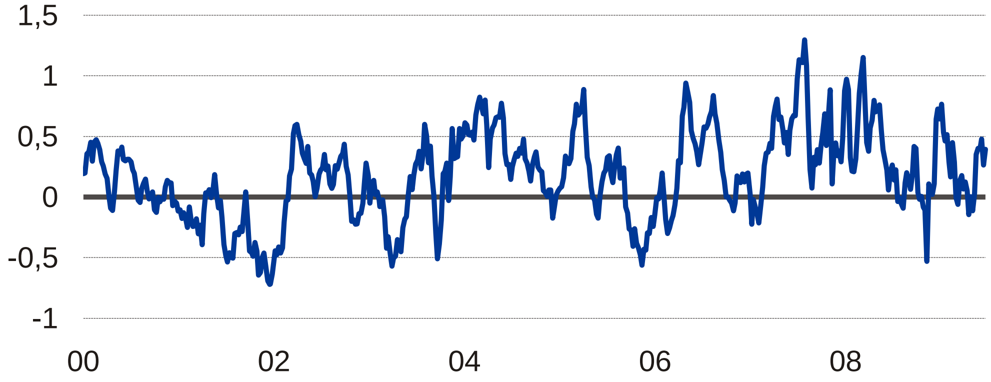
	(W3) ΔWTI	(W3P) ΔWTI	(M3) ΔWTI	(M3P) ΔWTI
Constants	-0.176	0.033	-0.598	0.074
	(0.157)	(0.083)	(0.788)	(0.251)
NetLong	1.494**	1.083**	5.350**	4.993**
	(0.296)	(0.209)	(0.917)	(0.759)
N	494	342	114	78
Period	Jan 00 - Jul 09	Jan 00 - Jul 06	Jan 00 - Jul 09	Jan 00 - Jun 06
R^2	0.05	0.06	0.11	0.34
DW	1.63	1.74	0.88	1.98

Calculation performed using Newey-West standard errors. ** at the 5% significance level.

The results suggest the following interpretations: a much larger increase in the turnover of long futures than of short futures is accompanied by price rises. The coefficient in specification (W3) of 1.49 implies a rise in the crude oil price of USD 1.49, if the number of long contracts exceeds the number of short contracts by 100,000. The mean NetLong figure for the entire sample is nearly 18,000 contracts. This means that the crude oil price rose by an average of USD 0.27 per week (=1.49×0.18) due to the dispersion of beliefs of speculators. Figure 2 shows the development of the NetLong variable over time.

Figure 2: NetLong Non-commercial

in 100,000



Sources: CFTC, DB Research

The regression results do not provide evidence of any causal link. It is possible that price rises cause speculators to become more active, while conversely having no impact on prices, however. Granger causality tests are conducted to determine the direction of causality. For short lag lengths the null hypothesis that “NetLong does not influence ΔWTI” can always be rejected at the 5% significance level, whereas the inverse null hypothesis cannot be rejected. For specifications with lag lengths higher than four both null hypotheses can be rejected, but presumably this may have more to do with size distortions of the Granger causality test than with higher lag lengths. Accordingly, the causality appears to run mainly from NetLong to WTI.

The results of the Granger causality test also raise the question of how strongly lagged NetLong terms impact on the crude oil price. Using the weekly data substituting NetLong_{t-1} for NetLong_t in equation (1) also produces a positive and significant impact.[8] Since in a multivariate regression with several lagged regressors multicollinearity problems arise – the correlation between NetLong and its lag is in part larger than 0.9 – we estimate a Polynomial Distributed Lag model (PDL). This involves rearranging the following equation

$$\Delta \text{WTI}_t = \beta_0 + \beta_1 \text{NetLong}_t + \beta_2 \text{NetLong}_{t-1} + ... + \beta_k \text{NetLong}_{t-(k-1)} + \text{u}_t$$

and at the same time reducing the number of parameters by packing the data into a predetermined polynomial structure. The disadvantage of a strictly predetermined structure compared with the advantage of avoiding multicollinearity problems is typically low since higher-order polynomials are particularly flexible. Rearrangement leads to the following equation

$$\Delta \text{WTI}_t = \gamma_0 + \gamma_1 \text{x}_1 + \gamma_2 \text{x}_2 + ... + \gamma_p \text{x}_p + \text{u}_t ,$$

where now $\text{x}_1 = \text{NetLong}_\text{t} + \text{NetLong}_\text{t-1} + ... + \text{NetLong}_\text{t-k} + \text{u}_t$, $\text{x}_p = (-\lambda)^{p-1}\text{NetLong}_\text{t} + (1-\lambda)^{p-1}\text{NetLong}_\text{t-1} + ... + (k-\lambda)^{p-1}\text{NetLong}_\text{t-k} + \text{u}_t$ for p>1 and $\gamma_0, \gamma_1, ..., \gamma_\text{p}$ contains the polynomial structure from which the β-coefficients can be replicated. Estimating the above equation with the aid of a PDL with 12 lags (k=12) and a fourth-degree polynomial (p=4) also produces a highly significant overall effect for NetLong (as the sum of contemporaneous and lagged NetLong variables) of 1.26^{**} (0.35) for the entire sample and of 0.77^{**} (0.21) for the 2006 sample. This means the long-run influence of the NetLong variable is less than the short-term effect, which compared with Table 3 in the PDL is much higher – in both the 2009 sample and the 2006 sample the coefficient is highly significant and larger than 3.

5 Impact of speculators on price volatility

In this section we test the second hypothesis and measure the influence of the dispersion of beliefs of speculators regarding the price volatility of WTI. The volatility test is conducted using a GARCH (p,q) process

$$\sigma_t^2 = \alpha + \beta \sum_p \sigma_{t-p}^2 + \gamma \sum_q \text{u}_{t-q}^2 + \left[\delta \, \text{NetLong}_{t-1}\right] + \text{u}_t$$

where σ^2 is the variance and u_t is the error term of the GARCH equation. The residuals are modelled using GED[9], since the crude oil yields have either fat tails in the case of weekly data or thin tails in the case of monthly data. The GED parameters are included with the regression

[8] Using monthly data we find a significant, delayed NetLong variable at the 10% significance level for the entire sample until Summer 2009 and almost at the 10% significance level for the sample until summer 2006.

[9] Acronym for generalized error distribution.

results in Table 4. If the residuals are modelled via a normal distribution the GED parameter has a value of 2, for values greater than 2 there are fat tails and with values smaller than 2 there are thin tails.

First, the lag lengths of the GARCH process are determined via the AIC criterion, with the term in brackets not being taken into consideration. After discovering the optimum lag length the specification is then extended with the NetLong variable. This regressor is always positive and – with the exception of specification M4P – significant[10] and explains part of the variance, so hypothesis 2 can be rejected fundamentally. The pre-crisis period until summer 2006 has a very similar explanatory level to the consideration of the whole sample.

Table 4 (W, M): Dependent variable: ΔWTI

GARCH (p,q)	**(W4) (1.1)**	**(W4P) (1.1)**	**(M4) (1.1)**	**(M4P) (2.1)**
Constant	0.009	0.012	-0.285**	-0.065
	(0.015)	(0.013)	(0.029)	(0.233)
ε_{t-1}^2	0.038**	0.004	-0.005	-0.147
	(0.012)	(0.010)	(0.019)	(0.093)
σ_{t-1}^2	0.962**	0.988**	1.058**	0.660**
	(0.014)	(0.011)	(0.013)	(0.0002)
σ_{t-2}^2				0.491**
				(0.128)
NetLong	0.069*	0.088**	0.861*	1.493
	(0.033)	(0.028)	(0.418)	(1.058)
GED parameter	1.673** (0.132)	1.631** (0.162)	2.44** (0.589)	3.52* (1.664)
N	493	342	114	78
Period	Jan 00 - Jun 09	Jan 00 - Jul 06	Jan 00 - Jun 09	Jan 00 - Jul 06
DW	1.57	1.64	0.94	1.92

AIC determine the optimum lag length of GARCH processes. * at the 1% significance level, ** at the 5% significance level.

[10] In specification M4P NetLong is, however, only significant at the 10% significance level.

6 Conclusions

The econometric estimates can reject the null hypotheses that the dispersion in beliefs of speculators has no influence on the crude oil price and its volatility. Both the Granger causality tests and the distributed lag models, which also include lagged regressors that measure the dispersion in beliefs of speculators, confirm moreover the role of speculation as a precursor to price movements.

There is no doubt that the significant regression results only represent apparent correlations. In a complex market like the crude oil market, with many different and partly difficult to quantify variables, there is however with regard to the modelling of estimation equations a trade-off between simple and more robust specifications and on the other hand a model that replicates the data-generating but is less robust and easily overfitted. In addition, the robust results suggest a causal relationship of speculators operating in the futures market on the crude oil spot price, both prior to and after the beginning of the financial crisis. This model cannot, however, reveal the motivation behind the positions built up in the futures market by speculators. Frequently changing fundamental factors can be the triggers just like simple excessive risk taking, in which investing external funds in a volatile market opens up the potential for the investor to make a small loss but a large profit.

The results do not only confirm the correctness of the new CFTC estimate, but also provide a reference point for an effective regulatory measure. The results do not imply a reduction in the activities of non-commercials, but show the significance of the dispersion in beliefs of non-commercials for the price of crude oil. Accordingly, a regulatory measure could be aimed at preventing the non-commercials in the futures market from displaying too wide a dispersion in beliefs, measured via the difference between long and short contracts. Constraining this difference by temporarily restrict trading or higher trading costs could possibly prevent a soaring crude oil price and elevated price volatility.

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