Original Article

Crude oil futures markets: Another look into traders' positions

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ABSTRACT We investigate the traders' futures-only positions, options-only positions and futures-and-options-combined positions in crude oil to draw some implications with respect to the behavior of traders during the 2008 oil bubble. We find that: (iv) the Money Manager group primarily speculated in crude oil markets via options on crude oil futures; (v) the Swap Dealer group generally behaved as a typical institutional long-only investor in crude oil – they were long crude oil futures and hedged with the long protective put options on crude oil futures; (vi) the Producer/Merchant/Processor/User group, in addition to being a short hedger, possibly acted as a counterparty in crude oil options markets; (vii) Other Reportable traders possibly engaged in the protective call risk management strategy; and (viii) the Non-Reportable traders group actually showed the most sophisticated, almost neutral, hedged position in crude oil futures and options on crude oil futures.

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INTRODUCTION

Many studies have analyzed the positions of traders in commodity futures markets (Chatrath *et al*, 1997; Roon *et al*, 2000; Wang, 2002; Weiner, 2002; Wang, 2003; Klitgaard and Weir, 2004; Sanders *et al*, 2004; Moulton, 2005; Till, 2009; Yung and Liu, 2009; Irwin and Sanders, 2010; Sanders and Irwin, 2010; Sanders and Irwin, 2011; Stoll and Whaley, 2011; Tokic, 2011). These studies usually test for the relationships between the traders' positions and

the price/volatility of the underlying commodity futures contracts.

The data on weekly positions of traders, published by the US Commodity Futures Trading Commission (CFTC) in the Commitment of Traders (COT), the Commodity Index Traders and the Disaggregated Commitment of Traders (DCOT) reports, is the standard database in similar studies. The DCOT Report, which is the final version of several revisions to the legacy COT Report, was created with the mission to increase

the transparency in crude oil futures markets. Thus, most studies investigating the 2008 oil bubble use the DCOT Report as the source of data on traders' positions. Masters (2008) heavily influenced the creation of the DCOT Report when he urged the US Congress to investigate the manipulation of crude oil futures prices during the 2008 oil bubble by the Swap Dealer category.

The DCOT Report publishes weekly positions of traders (each Friday the report reports the positions for Tuesday of the same week) by their respective categories and separates the report into the futures-only positions and futures-and-options combined positions. Most authors analyze the futures-and-options combined data, although some authors analyze the futures-only data. For example, Sanders *et al* (2004) use the futures-only COT data citing the high correlation between the futures-and-options-combined data and futures-only data during their sample interval 1995–1999. To the best of our knowledge, no study has estimated the options-only positions and analyzed them.

Furthermore, we also noticed that existing studies do not even discuss (or analyze) the relationship between the futures-only and futures-and-options combined data, perhaps assuming that the correlation cited by Sanders *et al* (2004) still holds during the period covered by the DCOT data, June 1996–December 2010. Thus, in this study (to fill the gap in the literature) we: (i) estimate the options-only positions in crude oil and (ii) take another look into traders' futures-only positions, options-only positions and futures-and-options-combined positions to investigate any significant differences between these positions and draw some implications with respect to the behavior of traders during the 2008 oil bubble.

Our analysis produces several important findings that, to the best of our knowledge, were overlooked by the existing literature: (i) the options-only positions are highly and negatively correlated with the futures-only positions; (ii) the options-only positions are highly and positively correlated with the combined positions; and (iii) the futures-only positions are barely correlated or negatively correlated with the combined positions, which shows that Sanders *et al*'s (2004) findings do not apply during the period covered by the DCOT Report data. We also find that: (iv) the Money Manager group primarily speculates in crude oil markets via options on crude oil futures; (v) the Swap Dealer group generally behaved as a typical institutional long-only investor in crude oil – they were long crude oil futures and hedged with the long protective put options on crude oil futures; (vi) the Producer/Merchant/Processor/User (P/M/P/U) group, in addition to being a short hedger, possibly acts as a counterparty in crude oil options markets; (vii) Other Reportable traders possibly engage in the protective call risk management strategy; and (viii) the Non-Reportable traders group actually shows the most sophisticated, almost neutral, hedged position crude oil futures and options on crude oil futures.

We briefly discuss the DCOT Report in the next section, and subsequently define some basic futures/options strategies that can clarify some of our implications. The subsequent section presents the analysis of each trader group's positions, and at the end we summarize with the key implications.

THE DCOT REPORT: BRIEF BACKGROUND

The Disaggregated Commitments of Traders Report, or the DCOT Report, is a weekly report

published by the US CFTC. The CFTC is an independent agency, created by the US Congress in 1974, with the mandate to regulate commodity futures and option markets in the United States. The CFTC separates traders into the following categories based on their responses on the CFTC Form 40 (see ctfc.com for definitions):

- A 'P/M/P/U' is an entity that predominantly engages in the production, processing, packing or handling of a physical commodity, and uses the futures markets to manage or hedge risks associated with those activities.
- A 'Swap Dealer' is an entity that deals primarily in swaps for a commodity and uses the futures markets to manage or hedge the risk associated with those swaps transactions. The swap/dealer's counterparties may be speculative traders, like hedge funds, or traditional commercial clients that are managing risk arising from their dealings in the physical commodity.
- A 'Money Manager', for the purpose of the DCOT Report, is a registered commodity trading advisor, a registered commodity pool operator or an unregistered fund identified by CFTC. These traders are engaged in managing and conducting organized futures trading on behalf of clients.
- Every Other Reportable trader that is not placed into one of the other three categories is placed into the 'Other Reportables' category.
- Non-Reportable traders' positions are derived by subtracting the total long 'Reportable Positions' and the total short 'Reportable Positions' from the total open interest.

The CFTC publishes the weekly positions of these traders in futures-only and futures-and-options-combined formats. Open interest is the total of all futures and/or options contracts

entered into and not yet offset by a transaction, by delivery, by exercise and so on. The aggregate of all long open interest is equal to the aggregate of all short open interest.

A trader's position is defined as the open interest held by that trader. For the futures-and-options-combined report, option open interest and traders' option positions are computed on a futures-equivalent basis using delta factors supplied by the exchanges. The term 'delta' is defined as the rate of change of the option price with respect to the price of the underlying asset. Long call and short put open interest are converted to long futures-equivalent open interest. Likewise, short-call and long-put open interest are converted to short futures-equivalent open interest. A trader's long and short futures-equivalent positions are added to the trader's long and short futures positions to give 'combined-long' and 'combined-short' positions. We further discuss the different speculation/hedging strategies using futures and options in the next section.

BASIC FUTURES AND OPTIONS STRATEGIES

Futures and options on futures can be used as the financial tools for speculation and hedging in commodities. In this section, we briefly discuss the key strategies that crude oil traders can use to speculate/hedge. First, we discuss the uncovered directional strategies used by traders that speculate on directional changes in crude oil prices. Second, we discuss the risk management strategies that can be used to hedge the speculative directional positions. Lastly, we discuss the basic hedging strategies by commercial market participants.

Directional uncovered strategies

- Long futures contract strategy

Traders speculating that the price of crude oil would rise within the specific time frame (intraday to longer term) can buy crude oil futures – go long crude oil. They would have to offset their open long position by going short, or by selling the contract for profit or loss before the contract expires. The futures account broker requires the trader to post the initial margin to buy crude oil futures, which is usually between 5 per cent and 10 per cent of the notional value of crude oil; thus, heavy leverage is involved. These contracts are market-to-market daily and the broker can require that a customer deposits more funds into the account if the account value drops below the maintenance margin level – the margin call.

- Short futures contract strategy

Traders speculating that the price of crude oil would fall within the specific time frame (intraday to longer term) can sell crude oil futures – go short crude oil. They would have to offset their open short position by going long, or buying back the contract for profit or loss before the contract expires. The short position is equivalent to the long positions with respect to the initial margin (heavily leveraged), the maintenance margin and the margin call procedure.

- Long call option strategy

Traders speculating that the price of crude oil would rise within the specific time frame can also buy a call option on crude oil futures – a long call position. A call option gives the right to buy crude oil at the specific strike price, within the specific time period. Call option buyers have to pay the premium or price for the option. If the

option expires worthless, the call option buyer can only lose the premium paid; thus, the losses are limited and there are no margin calls. On the other hand, the profit potential with call options is theoretically unlimited.

- Long put option strategy

Traders speculating that the price of crude oil would fall within the specific time frame can also buy a put option on crude oil futures – long put. A put option gives the right to sell crude oil at the specific strike price, within the specific time period. The long put position is equivalent to the long call position with respect to the premium paid, the limited loss and very large gain potential (although not unlimited since the price of crude oil cannot drop below 0) and no margin calls.

- Short call option strategy

Traders speculating that the price of crude oil would not rise as much (above the strike price) within the specific time frame can sell a call option – a short call position. Their profit is limited to the premiums received, whereas their loss potential is theoretically unlimited.

- Short put option strategy

Traders speculating that the price of crude oil would not fall as much (below the strike price) within the specific time frame can sell the put option – a short put position. Their profit is limited to the premiums received, whereas their loss potential is very large.

- Directional option spreads strategies

Options traders have many different strategies to speculate on direction on crude oil prices by combining long and short positions across different strike prices, different expirations (bull

spreads, bear spreads, strangles, straddles, calendar spreads and so on).

Hedged speculative positions (risk management)

- Protective put (portfolio insurance) risk management strategy

Long put options can also be used in combination with long futures positions, as insurance against unexpected drop in crude oil prices. Speculators that bet on rising oil prices by going long crude oil futures can hedge their long position by buying put options – the protective put strategy.

- Protective call risk management strategy

Long call options can also be used in combination with short futures positions, as insurance against unexpected rise in crude oil prices. Speculators that bet on falling oil prices by going short crude oil futures can hedge their short position by buying call options – the protective call strategy.

- Covered call strategy

Speculators that hold long futures positions can increase their cash inflow by selling call options against their long futures position. Thus, their profits will be limited if crude oil prices rise above the strike price of the call option, and their losses will be lessened by the amount of premium collected from short call positions if crude oil prices fall.

- Delta hedging strategy

More sophisticated speculators can engage in a dynamic delta-hedging strategy, for example by selling call options and buying optimal quantities of crude oil futures as oil prices rise and selling

crude oil futures as crude oil prices fall, to create a 0-delta position.

Basic commercial hedging strategies

- Short hedge

Commercial producers/merchants of crude oil can hedge their inventories (either in ground or in storage) by selling futures contracts against the inventory, thus fixing the profit margin. These participants are long the physical commodity such as crude oil, and short the commodity futures. The motive for short hedging can range from budgetary issues (for oil-producing countries) to profit issues (for commercial businesses) (see Swidler *et al*, 1999; Overdahl, 1987).

- Long hedge

Commercial consumers of crude oil can hedge their anticipated future need for crude oil inventories by buying futures contracts, thus fixing the profit margin. These participants are long futures contract and short cash. The motive for short hedging can also be due to budgetary issues (for oil-consuming countries) or profit issues (for commercial businesses).

ANALYSIS OF TRADERS' POSITIONS

We first plot the weekly futures-and-options-combined positions for each trader and make some initial observations about their trading demand/behavior. Next, we plot the futures-only positions and options-only positions and expand on our initial observation about the trading behavior of each trader. We compute options-only positions by deducting the futures-only positions from the combined positions

Equation (1).

$$\begin{aligned} Positions_{combined} - Positions_{futures} \\ = Positions_{options} \end{aligned} \quad (1)$$

Next, we confirm our observations about the positions of traders with the descriptive statistics and the cross-correlations between the futures-and-options-combined positions, futures-only positions and options-only positions. Finally, we test for the lead-lag relationships between the futures-and-options-combined positions, futures-only positions and options-only positions using the Granger causality test. We are interested to see, for example, whether the lagged futures-only positions Granger cause the current options-only positions, and vice versa (Granger, 1969). In essence, we run bivariate regressions in Equation (2).

$$\begin{aligned} y_t &= \alpha_0 + \alpha_1 y_{t-1} + \cdots + \alpha_i y_{t-i} + \beta_1 x_{t-1} \\ &\quad + \cdots + \beta_i x_{t-i} + \varepsilon_t \\ x_t &= \alpha_0 + \alpha_1 x_{t-1} + \cdots + \alpha_i x_{t-i} + \beta_1 y_{t-1} \\ &\quad + \cdots + \beta_i y_{t-i} + u_t. \end{aligned} \quad (2)$$

for all possible pairs of (x, y) series in the group. The reported F -statistics are the Wald statistics for the joint Equation (3).

$$\beta_1 = \beta_2 = \cdots = \beta_i = 0 \quad (3)$$

for each equation. The null hypothesis is that x does not Granger-cause y in the first regression and that y does not Granger-cause x in the second regression. The pairwise Granger causality test requires all variables to be stationary, or time independent and mean reverting. We run the Augmented Dickey–Fuller test Equation (4) to determine whether all of our variables are stationary.

$$\Delta y_t = a_0 + a_2 t + \gamma y_{t-1} + \sum_{i=2}^p \beta_i \Delta y_{t-1+i} + \epsilon_t \quad (4)$$

The Augmented Dickey–Fuller test is repeated for variables non-stationary in levels, transformed into first differences (see Table A1 in Appendix for the results of the augmented Dickey–Fuller test). We test for the optimal lag level using the AIC criteria, and the most optimal level appears to be at 1 week lag. We verified our results using different lags, but in most cases we find no pairwise causality at any lag level.

Analysis of the Money Manager group's positions

We plot the futures-and-options-combined positions of the Money Manager group in Figure 1 and observe the following:

- (1) the Money Manager group was net long crude oil during the entire period, which suggests that Money Managers acted as long-only investors in crude oil;
- (2) Money Managers had a relatively modest net long position in crude oil in 2006; in the second half of 2007, Money Managers sharply increased their net long positions and held those positions right into the top of the oil bubble in July of 2008;
- (3) after the bubble burst, in the second half of 2008, Money Managers sharply reduced their net long positions, suggesting that they almost perfectly played the 2008 oil bubble – got in early, got out in time;
- (4) Money Managers started to increase their net long positions as the price of crude oil bottomed during the period from late 2008 to early 2009;
- (5) these new net long positions eventually exceeded the net long positions in 2007, suggesting that Money Managers aggressively invested in crude oil in 2010.

Figure 1: Futures-and-options-combined positions for the Money Manager group. MMNLC-Money Manager net long combined.

Figure 2: Futures-only and options-only positions for the Money Manager group. MMNLO – Money Manager net long options, MMNLF – Money Manager net long futures.

We plot the futures-only and options-only positions of the Money Manager group in Figure 2 and observe the following:

- (1) the Money Manager group had a very large net long position in crude oil futures in 2006 and the second half of 2007;
- (2) the Money Manager group apparently hedged their large net long position in futures with a large net short position in crude oil options, which suggests that Money Managers were possibly engaged in a protective put risk

- management strategy – long futures and long put options;
- (3) Money Managers were reducing their net long positions from the second half of 2007 to the second half of 2008 after the oil bubble bust;
 - (4) Money Managers were first offsetting their protective puts as they were reducing their net long futures positions, and then in the second half of 2007 they actually possibly engaged in a speculative long call strategy (all the way to the top of the 2008 oil bubble) in a clear trend of rising net long interest, which possibly indicates the speculative positive feedback trading exclusively in options markets;
 - (5) after the 2008 oil bubble bust, Money Managers kept their futures net long positions relatively modest and stable, while they continued to significantly increase their net long positions in options.

On the basis of our analysis of Figures 1 and 2, we conclude that Money Managers chased oil prices primarily with call options, which makes sense knowing that by buying call options losses are limited, whereas gains are theoretically unlimited. Thus, a long call is a perfect strategy for chasing a bubble (which could get much larger, but also bust at any time). In addition, a very large combined net long position at the end of 2010 was also primarily due to a very large net long position in options, suggesting that oil prices were in the bubble again, or Money Managers anticipated a spike in crude oil prices due to the situation in the Middle East (the Arab Spring). We would also like to point to a change in behavior for

the Money Manager group from a relatively conservative long-futures-long-puts portfolio insurance strategy to a full-blown crude oil speculator via long-futures and particularly long-options strategies (this observation was discussed in United Nations, 2011 report.).

The descriptive statistics in Table 1 confirm that Money Managers were on average net long crude oil futures and crude oil options. While their futures-and-options-combined position has never dropped to negative territory, both futures-only positions and options-only positions were net short at some point.

The correlation matrix in Table 2 confirms the argument that Money Managers primarily speculate in crude oil via options since their futures-and-options-combined position is highly and positively (0.78) correlated with their options-only position. The options-only position is highly and negatively (−0.83) correlated with the futures-only position, partially due to protective put hedging and also due to the fact that Money Managers speculated primarily with options. The futures-and-options-combined position is negatively correlated (−0.30) with the futures-only position for crude oil.

Next, we question whether there is any pairwise Granger causality between the positions. Table 3 shows that the futures-only position Granger causes the options-only position with 1 week lag. In addition, we see bidirectional Granger causality between the combined position and the options-only position. This confirms our argument that Money Managers used options to strategically speculate on the crude oil while reducing their futures positions.

Table 1: Descriptive statistics for the Money Manager group

	<i>MMNLC</i>	<i>MMNLF</i>	<i>MMNLO</i>
Mean	94 571.57	73 368.54	21 203.03
Median	87 579.50	68 283.50	25 029.00
Maximum	208 915.0	202 221.0	203 377.0
Minimum	12 710.00	-42 735.00	-171 863.0
Standard deviation	44 628.63	49 931.16	76 447.59
Skewness	0.438 621	0.503 556	-0.166 260
Kurtosis	2.508 664	2.733 424	2.481 650
Jarque–Bera	10.02 540	10.76 292	3.760 967
Probability	0.006 653	0.004 601	0.152 516
Sum	22 508 034	1 746 1713	5 046 321
Sum of squared deviations	4.72E+11	5.91E+11	1.39E+12
Observations	238	238	238

MMNLO – Money Manager net long options, MMNLF – Money Manager net long futures,

MMNLC – Money Manager net long combined.

Table 2: Correlation matrix for the Money Manager group

	<i>MMNLC</i>	<i>MMNLF</i>	<i>MMNLO</i>
MMNLC	1.000 000	-0.305 022	0.783 004
MMNLF	—	1.000 000	-0.831 209
MMNLO	—	—	1.000 000

MMNLO – Money Manager net long options,

MMNLF – Money Manager net long futures,

MMNLC – Money Manager net long combined.

Analysis of the Swap Dealer group's positions

We plot the futures-and-options-combined positions of the Swap Dealer group in Figure 3 and observe the following:

- (1) the Swap Dealer's combined net long position was generally in a range from close to 0 to around 80 000 contracts, except in 2010 when the Swap Dealer's combined

position turned net short by close to 80 000 contracts;

- (2) the Swap Dealer was reducing its net long position from the beginning of 2007 to the second half of 2008; thus, there is no evidence of any speculative behavior during the oil bubble of 2008. On the contrary, the Swap Dealer group missed the opportunity to profit from the crude oil bubble.

We plot the futures-only and options-only positions of the Swap Dealer group in Figure 4 and observe the following:

- (1) the Swap Dealer was net long crude oil futures, except in 2006;
- (2) the Swap Dealer was net short crude oil options, except in 2006;
- (3) the plot of the net long futures-only positions and the net long options-only positions looks like a 'mirror image', suggesting that Swap Dealer hedged its net

Table 3: Pairwise Granger causality tests for the Money Manager group

Lags: 1

Null hypothesis	F-statistics	Probability
MMNLF does not Granger cause MMNLC	1.31 425	0.2528
MMNLC does not Granger cause MMNLF	0.60 120	0.4389
RMMNLO does not Granger cause MMNLC	3.64 321*	0.0575
MMNLC does not Granger cause RMMNLO	5.19 524**	0.0236
RMMNLO does not Granger cause MMNLF	0.23 615	0.6275
MMNLF does not Granger cause RMMNLO	4.63 156**	0.0324

* significant at 1% level; ** significant at 5% level

MMNLO – Money Manager net long options, MMNLF – Money Manager net long futures,

MMNLC – Money Manager net long combined.

Figure 3: Futures-and-options-combined positions for the Swap Dealer group.
SNLC-Swap Dealer net long combined.

long position in futures with put options – a protective put portfolio insurance risk management strategy;

- (4) the Swap Dealer group was actually increasing its net long futures-only position leading to the top of the 2008 oil bubble, which suggests some

speculative positive feedback trading (DeLong *et al*, 1990).

On the basis of our analysis of Figures 3 and 4, we conclude that the Swap Dealer group was primarily a long-only investor in crude oil futures, perfectly hedged with a protective

Figure 4: Futures only and options-only positions for the Swap Dealer group.
 SNLO – Swap Dealer net long options, SNLF – Swap Dealer net long futures SNLC – Swap Dealer net long combined.

Table 4: Descriptive statistics for the Swap Dealer group

	SNLC	SNLF	SNLO
Mean	35 342.84	99 596.79	−64 253.95
Median	37 244.50	95 607.50	−64 099.50
Maximum	106 176.0	210 415.0	94 702.00
Minimum	−91 292.00	−51 150.00	−190 789.0
Standard deviation	37 739.14	50 189.48	59 451.01
Skewness	−0.769 272	−0.213 625	0.069 821
Kurtosis	4.138 043	3.102 346	2.439 937
Jarque–Bera	36.31 745	1.914 085	3.303 937
Probability	0.000 000	0.384 027	0.191 672
Sum	8 411 597	23 704 037	−15 292 440
Sum of squared deviations	3.38E+11	5.97E+11	8.38E+11
Observations	238	238	238

SNLO – Swap Dealer net long options, SNLF – Swap Dealer net long futures, SNLC – Swap Dealer net long combined.

put as the portfolio insurance risk management strategy. But we also point to some positive feedback trading in crude oil futures leading to the top of the 2008 oil bubble,

which is unobservable in the combined net long positions due to heavy hedging activity in options markets. Table 4 confirms that on average the Swap Dealer group was net long

crude oil futures and net short crude oil options. In further support of this, Table 5 shows a high and negative correlation between the net long futures-only position and net long options-only position (-0.77). The correlation between the combined position and the options-only position is (0.54) and between the combined position and the futures-only position the correlation is (0.11) . Further analysis of the Swap Dealer's positions shows no pairwise Granger-type causality between positions (Table 6), further supporting the notion that Swap Dealers were primarily hedging their futures positions with options,

Table 5: Correlation matrix for the Swap Dealer group

	SNLC	SNLF	SNLO
SNLC	1.000 000	0.107 915	0.543 691
SNLF	—	1.000 000	$-0.775\ 712$
SNLO	—	—	1.000 000

SNLO – Swap Dealer net long options, SNLF – Swap Dealer net long futures, SNLC – Swap Dealer net long combined.

and not engaged in any strategic speculative futures-options strategy.

Analysis of the P/M/P/U group's positions

It is important to note that the P/M/P/U group should be engaged in (as a commercial participant) either a long hedge or short hedge. We plot the futures-and-options-combined positions of the P/M/P/U group in Figure 5 and observe the following:

- (1) the P/M/P/U group was net short crude oil during the entire period, which suggests that members of the P/M/P/U group were mostly Producers/Merchants with the long position in the physical crude oil, hedged with the short position in crude oil futures/options;
- (2) the net short position is in a downtrend, possibly suggesting an increase in crude oil inventories in 2010;
- (3) the P/M/P/U group was actually reducing their net short positions from 2007 leading into the 2008 oil bubble peak, which suggests some unwilling positive feedback trading (see Tokic, 2011).

Table 6: Pairwise Granger causality tests for the Swap Dealer group

Lags: 1

<i>Null hypothesis</i>	<i>Observations</i>	<i>F-statistics</i>	<i>Probability</i>
SNLF does not Granger cause SNLC	237	0.53 840	0.4638
SNLC does not Granger cause SNLF		0.08 999	0.7645
SNLO does not Granger cause SNLC	237	0.53 840	0.4638
SNLC does not Granger cause SNLO		0.03 159	0.8591
SNLO does not Granger cause SNLF	237	0.08 999	0.7645
SNLF does not Granger cause SNLO		0.03 159	0.8591

SNLO – Swap Dealer net long options, SNLF – Swap Dealer net long futures, SNLC – Swap Dealer net long combined.

Figure 5: Futures-and-options-combined positions for the P/M/P/U group.
PMNLC – P/M/P/U net long combined.

Figure 6: Futures-only and options-only positions for the P/M/P/U group.
PMNLO – P/M/P/U net long options, PMNLF – P/M/P/U net long futures.

We plot the futures-only and options-only positions of the P/M/P/U group in Figure 6 and observe the following:

- (1) the P/M/P/U group was net short crude oil futures during the entire period;
- (2) we see a significant reduction in futures-only net short positions from the 2007 into the 2008 oil bubble top and after the 2008 oil bubble bust, suggesting that the P/M/P/U group engaged in positive feedback trading in crude oil futures and contributed to the rising

Table 7: Descriptive statistics for the P/M/P/U group

	<i>PMNLC</i>	<i>PMNLF</i>	<i>PMNLO</i>
Mean	−147 916.7	−148 928.5	1011.790
Median	−155 765.5	−142 412.0	891.5000
Maximum	−33 011.00	−46 420.00	177 327.0
Minimum	−240 744.0	−257 895.0	−134 121.0
Standard deviation	44 599.27	53 832.43	79 004.27
Skewness	0.110 408	−0.171 176	0.101 281
Kurtosis	2.243 195	1.825 294	1.794 999
Jarque–Bera	6.163 339	14.84 663	14.80 616
Probability	0.045 883	0.000 597	0.000 609
Sum	−35 204 172	−35 444 978	240 806.0
Sum of squared deviations	4.71E+11	6.87E+11	1.48E+12
Observations	238	238	238

RPMNLO – P/M/P/U net long options (first difference), RPMNLF – P/M/P/U net long futures (first difference), RPMNLC – P/M/P/U net long combined (first difference).

- oil prices in 2007 and 2008, and also provided some support to the crashing crude oil prices post the bubble bust;
- (3) the P/M/P/U group hedged their significant net short futures-only position in 2006 and 2007 with call options – a protective call risk management strategy – or possibly sold put options to hedging Swap Dealers (see Figure 2);
 - (4) post the 2008 oil bubble bust, the P/M/P/U group kept their net short futures-only position relatively modest and stable;
 - (5) however, the P/M/P/U group became net short crude oil options, possibly suggesting that the P/M/P/U group was selling call options and collecting premiums from the Money Manager group (see Figure 4);
 - (6) thus, there is a noticeable change in behavior of the P/M/P/U group from the option hedged net short futures-only position to a counterparty in speculative crude oil options markets.

Table 7 shows that the P/M/P/U group was on average net short crude oil futures, and only negligibly on average net long crude oil options. However, the descriptive statistics can be misleading in this case. We showed that the P/M/P/U group was possibly a counterparty in a speculative options market by selling call options to the speculative Money Manager group and possibly selling put options to the Swap Dealer. In support, Table 8 shows a very high and positive correlation between the options-only positions and the combined positions (0.75) and a very high and negative correlation between the options-only and futures-only positions (−0.84). The futures-only position is actually negatively correlated with the combined position (−0.28). Thus, it is very important to acknowledge the importance of activity of the P/M/P/U group in crude oil options markets. Table 9 shows no Granger-type causality between the options-only and futures-only positions, suggesting that the

P/M/P/U group did not engage in a strategic (speculative or hedging) futures-options strategy. In support of this, the options-only positions and the futures-only positions both Granger-cause the combined positions.

Analysis of the Other Reportable group's positions

We plot the futures-and-options-combined positions of the Other Reportable group in Figure 7 and observe the following:

- (1) Other Reportable crude oil traders were switching between modest net long and net

Table 8: Correlation matrix for the P/M/P/U group

	<i>PMNLC</i>	<i>PMNLF</i>	<i>PMNLO</i>
<i>PMNLC</i>	1.000 000	−0.282 114	0.756 746
<i>PMNLF</i>	—	1.000 000	−0.840 645
<i>PMNLO</i>	—	—	1.000 000

RPMNLO – P/M/P/U net long options (first difference), RPMNLF – P/M/P/U net long futures (first difference), RPMNLC – P/M/P/U net long combined (first difference).

short combined positions during the period of rising oil prices from 2006 to the first half of 2008;

- (2) the Other Reportable group significantly increased their net long positions after the oil bubble burst and remained net long crude oil for the rest of the period, although with increased volatility.

We plot the futures-only and options-only positions of the Other Reportable group in Figure 8 and observe the following:

- (1) the Other Reportable group was actually net short crude oil futures in 2006, 2007 and the beginning of 2008, and turned net long crude oil futures right into the peak of the 2008 oil bubble top, which suggests short covering by Other Reportable traders (or unwilling positive feedback trading);
- (2) post the 2008 oil bubble bust, the Other Reportable group remained mostly net short crude oil futures;
- (3) during the entire period, Other Reportable traders hedged their net short positions in crude oil futures with long positions in crude oil options – the protective call risk

Table 9: Pairwise Granger causality tests for the P/M/P/U group

<i>Lags: 1</i>			
<i>Null hypothesis</i>	<i>Observations</i>	<i>F-statistics</i>	<i>Probability</i>
RPMNLF does not Granger Cause RPMNLC	236	3.18 388	0.0757
RPMNLC does not Granger Cause RPMNLF		0.17 486	0.6762
RPMNLO does not Granger Cause RPMNLC	236	3.18 388	0.0757
RPMNLC does not Granger Cause RPMNLO		0.00 301	0.9563
RPMNLO does not Granger Cause RPMNLF	236	0.17 486	0.6762
RPMNLF does not Granger Cause RPMNLO		0.00 301	0.9563

RPMNLO – P/M/P/U net long options (first difference), RPMNLF – P/M/P/U net long futures (first difference), RPMNLC – P/M/P/U net long combined (first difference).

Figure 7: Futures-and-options-combined positions for the Other Reportable group.
ORNLC – Other Reportable net long combined.

Figure 8: Futures-only and options-only positions for the Other Reportable group.
ORNLO – Other Reportable net long options, ORNLF – Other Reportable net long futures.

management strategy. The plot of the options-only and the futures-only positions resembles a mirror image.

The descriptive statistics in Table 10 confirm that the Other Reportable group was on average

net long crude oil options and net short crude oil futures. Furthermore, the correlation matrix in Table 11 shows a very high and negative correlation between the options-only position and the futures-only position (-0.86), further supporting the ‘mirror image’ observation of the

Table 10: Descriptive statistics for the Other Reportable group

	<i>ORNLC</i>	<i>ORNLF</i>	<i>ORNLO</i>
Mean	17 898.26	−23 698.83	41 597.09
Median	18 284.00	−30 280.00	42 494.00
Maximum	52 579.00	45 447.00	107 841.0
Minimum	−14 999.00	−77 986.00	−37 127.00
Standard deviation	15 276.13	26 743.07	30 281.97
Skewness	0.023 769	0.452 636	−0.172 448
Kurtosis	2.262 715	2.351 395	2.544 319
Jarque–Bera	5.413 006	12.29 871	3.238 765
Probability	0.066 770	0.002 135	0.198 021
Sum	425 9785	−5 640 322	9 900 107
Sum of squared deviations	5.53E+10	1.70E+11	2.17E+11
Observations	238	238	238

ORNLO – Other Reportable net long options, ORNLF – Other Reportable net long futures, ORNLC – Other Reportable net long combined.

protective call risk management. The options-only position is also positively correlated with the combined position (0.47) whereas the combined position is not correlated with the futures-only position (0.03), which further shows the importance of options activity in crude oil markets for Other Reportable traders. We do not find Granger-type causality among pairs, which rules out any speculative lead–lag futures–options strategy and supports the protective call hedging by the Other Reportable group (see Table 12).

Analysis of the Non-Reportable group's positions

We plot the futures-and-options-combined positions of the Non-Reportable group in Figure 9 and observe the following:

- (1) the Non-Reportable group was mostly net short crude oil before the 2008 oil bubble peak, and mostly net long crude oil post the 2008 oil bubble peak.

Table 11: Correlation matrix for the Other Reportable group

	<i>ORNLC</i>	<i>ORNLF</i>	<i>ORNLO</i>
ORNLC	1.000 000	0.038 619	0.470 357
ORNLF	—	1.000 000	−0.863 653
ORNLO	—	—	1.000 000

ORNLO – Other Reportable net long options, ORNLF – Other Reportable net long futures, ORNLC – Other Reportable net long combined.

We plot the futures-only and options-only positions of the Non-Reportable group in Figure 10 and observe the following:

- (1) the Non-Reportable group was actually mostly net long crude oil futures before the 2008 oil bubble peak and mostly net short crude oil futures post the 2008 oil bubble peak;

Table 12: Pairwise Granger causality tests for the Other Reportable group
Lags: 1

<i>Null hypothesis</i>	<i>Observations</i>	<i>F-statistics</i>	<i>Probability</i>
ORNLF does not Granger cause ORNLC	237	0.40 826	0.5235
ORNLC does not Granger cause ORNLF		0.04 414	0.8338
ORNLO does not Granger cause ORNLC	237	0.40 826	0.5235
ORNLC does not Granger cause ORNLO		0.00 016	0.9901
ORNLO does not Granger cause ORNLF	237	0.04 414	0.8338
ORNLF does not Granger cause ORNLO		0.00 016	0.9901

ORNLO – Other Reportable net long options, ORNLF – Other Reportable net long futures, ORNLC – Other Reportable net long combined.

(2) the Non-Reportable group hedged their net long futures position with the net short option positions – a protective put risk management strategy (portfolio insurance). We see a rising trend of options-only position and a falling trend of futures-only position, intersecting right at the top of the 2008 oil bubble.

The descriptive statistics in Table 13 show that Non-Reportable traders had on average a very small net long combined position, and on average they were net short futures and net long options, which indicates an almost perfectly hedged (close-to-zero delta) position in crude oil futures and options. The correlation matrix in Table 14 confirms a very high and negative correlation between the options-only and the futures-only positions (-0.81), and a very high and positive correlation between the options-only and combined positions (0.80), while the combined position is negatively correlated with the futures-only position (-0.30), which further shows the importance of options positions even for the Non-Reportable group. We find no Granger-type causality among positions, which supports

the notion that Non-Reportable traders use options only to hedge their futures positions (see Table 15).

SUMMARY AND KEY IMPLICATIONS

Behavior of traders

Our analysis shows that:

- (1) the Money Manager group primarily speculates in crude oil markets via options on crude oil futures. They possibly engaged in positive feedback trading leading to the top of the 2008 oil bubble by increasing their net long options-only positions, an activity unobservable in futures-only positions and the combined positions;
- (2) the Swap Dealer group generally behaves as a typical institutional long-only investor in crude oil – with the long crude oil futures position hedged with the protective put options on crude oil futures;
- (3) the P/M/P/U group is a short hedger; however, we also raise a possibility that this group

Figure 9: Futures-and-options-combined positions for the Non-Reportable group.
NRNLC – Non-Reportable net long combined.

Figure 10: Futures-only and-options-only positions for the Non-Reportable group.
NRNLO – Non-Reportable net long options, NRNLF – Non-Reportable net long futures.

acts as a counterparty in crude oil options markets, by selling put options to hedgers (Swap Dealers, for example) and call options to speculators (Money Managers, for example);

(4) Other Reportable traders are generally net short crude oil futures, and they hedge their short futures position by being net long crude oil futures options – possible protective call risk management strategy;

Table 13: Descriptive statistics for the Non-Reportable group

	<i>NRNLC</i>	<i>NRNLF</i>	<i>NRNLO</i>
Mean	103.8193	−338.0252	441.8445
Median	−1605.500	−2031.000	−583.0000
Maximum	32 653.00	36 061.00	50 065.00
Minimum	−28 931.00	−39 109.00	−51 608.00
Standard deviation	13 395.45	13 652.17	21 820.03
Skewness	0.370 708	0.216 811	−0.017 121
Kurtosis	2.605 791	2.796 245	2.312 402
Jarque–Bera	6.992 231	2.276 320	4.700 139
Probability	0.030 315	0.320 408	0.095 363
Sum	24 709.00	−80 450.00	105 159.0
Sum of squared deviations	4.25E+10	4.42E+10	1.13E+11
Observations	238	238	238

NRNLO – Non-Reportable net long options, NRNLF – Non-Reportable net long futures, NRNLC – Non-Reportable net long combined.

Table 14: Correlation matrix for the Other Reportable group

	<i>NRNLC</i>	<i>NRNLF</i>	<i>NRNLO</i>
NRNLC	1.000 000	−0.301 552	0.802 579
NRNLF	—	1.000 000	−0.810 796
NRNLO	—	—	1.000 000

NRNLO – Non-Reportable net long options,
NRNLF – Non-Reportable net long futures,
NRNLC – Non-Reportable net long combined.

(5) the Non-Reportable traders group, which is supposed to represent small noise traders, actually shows the most sophisticated hedged position – almost neutral, perfectly hedged position in crude oil futures and options.

position and the options-only positions shows that:

- (1) the options-only positions are highly and negatively correlated with the futures-only positions for all groups of traders (the range for the coefficient of correlation is from (−0.77) to (−0.86));
- (2) the options-only positions are highly and positively correlated with the combined positions for all groups of traders (the range for the coefficient of correlation is from (0.47) to (0.80));
- (3) the futures-only positions show low and even negative correlations with the combined positions (the range for the coefficient of correlation is from (−0.30) to (0.10)).

Importance of the options-only position

The cross-correlation analysis between the combined positions, the futures-only

Key implications

This article shows that it is necessary to fully analyze the combined-futures-and-options data, the futures-only data and the options-only data

Table 15: Pairwise Granger causality tests for the Non-Reportable group*Lags: 1*

<i>Null hypothesis</i>	<i>Observations</i>	<i>F-statistics</i>	<i>Probability</i>
NRNLF does not Granger cause NRNLC	237	2.07 674	0.1509
NRNLC does not Granger cause NRNLF		1.61 747	0.2047
NRNLO does not Granger cause NRNLC	237	2.07 674	0.1509
NRNLC does not Granger cause NRNLO		0.09 274	0.7610
NRNLO does not Granger cause NRNLF	237	1.61 747	0.2047
NRNLF does not Granger cause NRNLO		0.09 274	0.7610

NRNLO – Non-Reportable net long options, NRNLF – Non-Reportable net long futures, NRNLC – Non-Reportable net long combined.

on positions of traders in crude oil futures markets to get a better understanding on how crude oil traders really behave. The implications can be very important for regulators brainstorming the possible regulation of crude oil futures markets, as some patterns that emerge in options-only positions are generally unobservable in combined or futures-only positions.

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APPENDIX

Table A1: Augmented Dickey–Fuller unit root test

<i>Variable</i>	<i>Level</i>	<i>First difference</i>
ORNLC	−4.21***	—
ORNLF	−3.74***	—
ORNLO	−3.91***	—
NRNLC	−3.18**	—
NRNLF	−3.81***	—
NRNLO	−2.63*	—
PMNLC	−2.13	−17.02***
PMNLF	−1.35	−15.40***
PMNLO	−1.42	−17.55***
MMNLC	−2.69*	—
MMNLF	−3.16**	—
MMNLO	−2.56	−14.16***
SNLC	−3.28**	—
SNLF	−3.52***	—
SNLO	−3.92***	—

Notes: * significant at 1% level; ** significant at 5% level; *** significant at 10% level.