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The Impact of Financialization on the WTI Market

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n. 04/2012

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Abstract

In this paper, I investigate the impact of three classes of investors – money managers, swap providers and commercial operators – on the level and volatility of WTI prices over the period 2006-2010. I find a significant volatility-reducing impact of money manager activity. This is true of both implied and conditional volatility measures. There is no evidence that swap providers affected the level of WTI prices. They appear to have reduced implied WTI volatility but increased conditional volatility.

JEL classification: G110

Acknowledgement: I am grateful to Christopher Gilbert for his suggestions and comments.

1 Introduction

Crude oil markets saw high volatility over the five years 2006-2010. The WTI price rose sharply from 2006 to mid-2008 to reach a high of $147 per barrel. It then fell back with the 2008 financial crisis spread, bottoming at just over $30. It subsequently increased returning to around $90 by the end of 2010.

The Commodities Futures Trading Commission (CFTC) identifies four main classes of investors in commodities markets: *producer/merchant/processor/user*, *money manager*, *swap dealer* and *other reportable*. According to CFTC definitions, to be included in the *producer/merchant/processor/user category,* one must be 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 these activities. A *money manager* is engaged in managing and conducting organized futures trading on behalf of clients. It can be a registered commodity trading advisor (CTA), a registered commodity pool operator (CPO), or an unregistered fund identified by CFTC. 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 swap transactions. Every other reportable trader that is not placed into one of the other three categories is placed into the *other reportable* category (CFTC, 2008).

Money managers are often interpreted as hedge funds, but the category also includes pension funds and other large investors which directly take futures positions. They take a position (either long or short, or spreading) based on their market view. Hedge funds will often operate with high leverage and many of these close out positions after only short holding periods.

The money manager category also includes some index investors. Index investors invest in commodity futures with the aim of replicating one of a number of tradable commodity futures indices (Dow Jones-UBSCI or S&P-GSCI) in order to diversify their portfolios (Gorton, Rouwenhorst, 2006)[1]. These investors will typically operate buy-hold-roll strategies. A larger proportion of index investment is attributable to the swap provider category. Swap providers, typically investment banks, offer floating for fixed swaps in which the floating arm is defined in terms of the returns on one of the tradable commodity futures indices (more complicated swap structures are also possible).

[1] The authors show that from 1959 to 2004 the risk premium on commodity futures is essentially the same as equities, but commodity returns are negatively correlated with equity and bond returns.

The following table reports the notional value of the total index investments in WTI from December 2007 to December 2011[2].

Table 1: total index investment in WTI (billion US$)

	Long	**(Short)**	**Net**
December 2011	59.6	(18.0)	**41.5**
June 2011	66.4	(18.9)	**47.5**
December 2010	57.4	(15.7)	**41.7**
June 2010	51.2	(12.9)	**38.3**
December 2009	50.7	(14.3)	**36.4**
June 2009	42.1	(11.7)	**30.4**
December 2008	24.6	(4.4)	**20.1**
June 2008	62.9	(11.5)	**51.4**
December 2007	46.7	(7.0)	**39.6**

Source: "Index Investment Data" (CFTC website), which reports the notional value and the futures equivalent contracts of index investments over 19 different commodities; from June 2010 data are available on a monthly basis

It is important to remember that swap providers also have substantial non-index business: in the energy markets, swap dealers are widely involved in OTC transactions, including commercial operators. It is therefore possible that their position in futures markets may not reflect fully index investor activity. For example, the CFTC estimates that only 41 percent of long swap dealer positions in crude oil futures on three dates in 2007 and 2008 are linked to long-only index fund positions (Irwin, Sanders, 2010). On the other hand, index investors such as some pension funds which take replicating futures positions on their own account, will be included in the money managers category, as mentioned before.

Swap providers and money managers have been seen as a main driver of recent WTI volatility[3]. Index investors, in particular, have been heavily criticized by some commentators due to their mode of investing – a simple buy-hold-roll approach would tie up a large long position which would then be unavailable to accommodate other market transactors over the holding period. Policymakers in both the United States and Europe have been asked to consider restriction of the activities of these investors (Masters, 2008). In the US, the CFTC decided to limit position sizes on futures markets

[2] Data from "Index Investment Data", CFTC website.

[3] "Soros blasts commodity bubble", ft.com/markets, June 4, 2008, http://www.ft.com/intl/cms/s/0/d9056350-3261-11dd-9b87-0000779fd2ac.html#axzz1jcP9U5Cs

as part of the implementation of the Dodd-Frank Act[4]. Similar restrictions have been proposed in Europe by the French government[5].

All of this conveys the idea that "speculation" is damaging for markets, because it increases their instability (that is, it moves prices away from fundamentals, thereby increasing their volatility). The opposite view derives from Friedman (1953), who stated that speculators buy when prices are low and sell when prices are high, and hence will tend to be volatility-reducing.

Recently, several studies have been carried out over this issue. For example, Fan and Xu (2011) state that speculation has been a highly influential factor on oil price changes from 2000 to 2008. On the other hand, Irwin and Sanders (2011) find very little evidence that index investor activity influenced price and volatility of 19 commodities (using data from the Index Investment Data). They also prove that there has been no causal link between daily returns and volatility in the crude oil and natural gas futures markets and the positions of two large exchange-traded index funds.

In what follows, I report the impact of the different categories of investors on WTI returns. I first analyze the impact on WTI prices and then the impact on WTI volatility.

The remainder of this paper is organized as follows: section 2 describes the procedure adopted, with a brief description of the different variables. Section 3 shows the results of price analysis, while in section 4 and 5 the analyses of implied and conditional volatility respectively are reported. Conclusions are in section 6.

2 Procedure

Investor data are from the disaggregated Commitment of Traders reports, downloaded from the CFTC website. This reports weekly investor positions over the range of U.S. commodities futures markets. The different classes of investors are the four mentioned above. I analyze the impact of *producer/merchant/processor/user*, *money manager* and *swap dealer*, not considering the *other reportable* category. I use futures-only positions, excluding options. The sample is from June 13th, 2006 to December 28th, 2010, for a total of 238 observations.

In the analysis, I use the week-on-week changes in investors net position, divided by the open interest of the day (spreading positions are not considered).

[4] "CFTC raises bar on betting", online.wsj.com, October 19, 2011
http://online.wsj.com/article/SB10001424052970204346104576638973617953958.html

[5] "Sarkozy urges firmer commodity rules", ft.com/globaleconomy, June 14, 2011,
http://www.ft.com/intl/cms/s/0/96a70cba-968c-11e0-afc5-00144feab49a.html#axzz1jcP9U5Cs

Δ (Long – Short)/ Total Open Interest

I constructed the futures price curve using the front contract price[6], and rolling the contract on 15th of every month or, if the 15th was a weekend or holiday, the immediately preceding trading day. The choice of that day is to avoid using a price too close to the expiration date, when trading on the expiring contract becomes thin. Returns are calculated by the formula:

$$r_t = ln\,(f_t) - ln\,(f_{t-1})$$

where f_t and f_{t-1} represent the futures price at time t and $t-1$ respectively. The returns of the roll days are calculated using the new futures contract, not the continuous futures.

I consider two measures of volatility: the forward-looking implied volatility measure derived from WTI options, and the backward looking conditional volatility (GARCH) volatility measure. Implied volatility is calculated as the average of the nearest at-the-money call and put implied volatility[7]. The data sample for the implied volatility analysis starts from September 1st, 2006 and ends on December 28th, 2010.

To examine price impact, I use Granger-causality tests between changes in investor positions and returns, and also contemporaneous relations, using instrumental variables estimation. The use of these variables is due to the possible presence of correlation between regressors and the error terms, which might result in coefficient bias (Stock, Watson, 2005). For implied volatility, I again use a Granger causality approach, and then calculate impulse-response functions to determine the direction of the impact. I test for the impacts on conditional volatility using a GARCH-X model, where lagged changes in investors positions are the additional variables (Gallo, Pacini, 2002).

ADF tests (not reported) show that both returns, volatility changes and position changes are stationary. To guard against heteroskedasticity, robust standard errors are reported throughout. When using a VAR model, the number of lags is determined by the Akaike Criterion Information (AIC). In the case of presence of residual autocorrelation, further lags are added, their significance being evaluated using a Wald lag exclusion test.

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[6] WTI futures price data from www.normahistoricaldata.com

[7] Data provided by Datastream.

3 Price analysis

The initial step is to test Granger causality between week-on-week changes in investor net positions and week-on-week changes in logarithm of prices. I consider the first equation of a four variable VAR(3). The AIC suggests to use only one lag, but residuals are highly correlated; adding two more lags eliminates the autocorrelation, and a lag exclusion test confirms that the third lag is significant. The equation is

$$\Delta \ln f_t = \alpha + \sum_{j=1}^{3} \beta_j \Delta \ln f_{t-j} + \sum_{j=1}^{3} \gamma_j \Delta\, money_{t-j} + \sum_{j=1}^{3} \eta_j \Delta\, producer_{t-j} + \sum_{j=1}^{3} \lambda_j \Delta\, swap_{t-j} + u_t \qquad (1)$$

where *money*, *producer* and *swap* are the net positions of *money managers*, *producer/merchant…*, and *swap dealers* respectively, each one divided by the open interest.

The Granger-causality test statistic for each category of investors is the Wald test on the relevant lag distribution. It shows if past values of the position variable can contribute to the accuracy of price change forecasts. The null hypothesis is the absence of Granger-causality. In a 4 variables VAR there are three null hypotheses for each equation (one for each lag distribution) plus the joint hypothesis. Considering the equation (1), we have

1. H_0: $\gamma_1 = \ldots \gamma_3 = 0$; 2. H_0: $\eta_1 = \ldots \eta_3 = 0$; 3. H_0: $\lambda_1 = \ldots \lambda_3 = 0$

Joint. H_0: $\gamma_1 = \ldots \gamma_3 = \eta_1 = \ldots \eta_3 = \lambda_1 = \ldots \lambda_3 = 0$

If the WTI futures market is efficient, one should expect any price impact from trading to be instantaneous: the *weak form* of the Efficient Market Hypothesis states that prices fully reflect all the available past information, otherwise it would be possible to make extra-profits on the basis of that information (Fama, 1970). As a consequence, price should change only when new information is available.

The following table shows the p-values of the test. The only case where the null hypothesis is rejected is that of the *money managers*, with a 5% level of confidence. Money manager activity therefore does appear to have had a predictive power in relation to price movements. *Producers* and *swap dealers* activities do not Granger-cause changes in prices. Looking at the other three equations in the VAR, we can see that in no case do price changes Granger-cause investor position changes. Thus, none of the three categories appears to be a “trend follower”.

Table 2: Granger causality test

	Δ net position NGC Δ ln f	**Δ ln f NGC Δ net position**
Money managers	**0.0462**	0.6986
Producers	0.7383	0.5161
Swap dealers	0.6096	0.5461
All	0.2131	

Note: the table shows the p-values of the Granger non-causality test between changes in the logarithm of WTI price and changes in investor net position. In the first column the null hypothesis that changes in investor net positions do not Granger cause (NGC) changes in returns is tested; in the second, that changes in returns do not Granger cause changes in net positions. A rejection of the null hypothesis means that Granger causality is accepted. The model is a 4 variables VAR(3).

The Granger-causality tests are uninformative in relation to contemporaneous interactions. For these reasons, I consider the following equation

$$\Delta\ ln\ f_t = \alpha + \sum_{j=1}^{3} \beta_j\ \Delta\ ln\ f_{t-j} + \gamma\ \Delta\ money_t + \eta\ \Delta\ producer_t + \lambda\ \Delta\ swap_t + u_t \qquad (2)$$

Instrumental variables: *Δ money(-1), Δ money(-2), Δ money(-3), Δ producer(-1), Δ producer(-2), Δ producer(-3), Δ swap(-1), Δ swap(-2), Δ swap(-3), Δ ln f(-1), Δ ln f(-2), Δ ln f(-3)*

The equation is estimated using instrumental variables, where the instrumental variables are three lagged values both of returns and investor activity. Since Granger-causality shows the presence of relations with lagged values, regressors could be correlated with the error terms: in an ordinary OLS estimation, coefficients could be biased. Use of instrumental variables should eliminate this bias. The specification includes lagged values of the dependent variable to control for possible residual autocorrelation. The output is reported in the next table: we can see that *money* is the only significant variable of the regression, and it is positive.

Table 3: OLS estimation with instrumental variables

Variable	Coefficient	t-statistic	p-value
C	-0.000588	-0.163868	0.8700
Δ money	**3.907078**	**2.136406**	**0.0337**
Δ producer	0.891997	0.609007	0.5431
Δ swap	0.801720	0.705218	0.4814
Δ ln f(-1)	-0.135059	-1.211467	0.2270
Δ ln f(-2)	0.064511	0.672868	0.5017
Δ ln f(-3)	0.226165	2.036842	0.0428

Note: the table reports the results of the contemporaneous impact of changes in investor net positions on changes in the logarithm of prices. This is an OLS estimation with the use of instrumental variables. The instrumental variables are 3 lagged changes both in investor net positions and in logarithm of prices.

This result allows us to say that causality runs from *money managers* to prices: *money manager* activity has had a positive impact on prices. This confirms the result of the Granger causality analysis.

4 Implied volatility analysis

The first measure of volatility analyzed is implied volatility from WTI options. This is a forward looking measure. The analysis proceeds as previously by testing Granger-causality between investor activity and volatility changes. I use a VAR(5) with four variables. The AIC suggests 4 lags, but I add one more lag in order to completely eliminate the residual autocorrelation. A lag exclusion test confirms the significance of the 5^{ft} lag.

$$\Delta \sigma_t = \alpha + \sum_{j=1}^{5} \beta_j \Delta \sigma_{t-j} + \sum_{j=1}^{5} \gamma_j \Delta money_{t-j} + \sum_{j=1}^{5} \eta_j \Delta producer_{t-j} + \sum_{j=1}^{5} \lambda_j \Delta swap_{t-j} + u_t \quad (3)$$

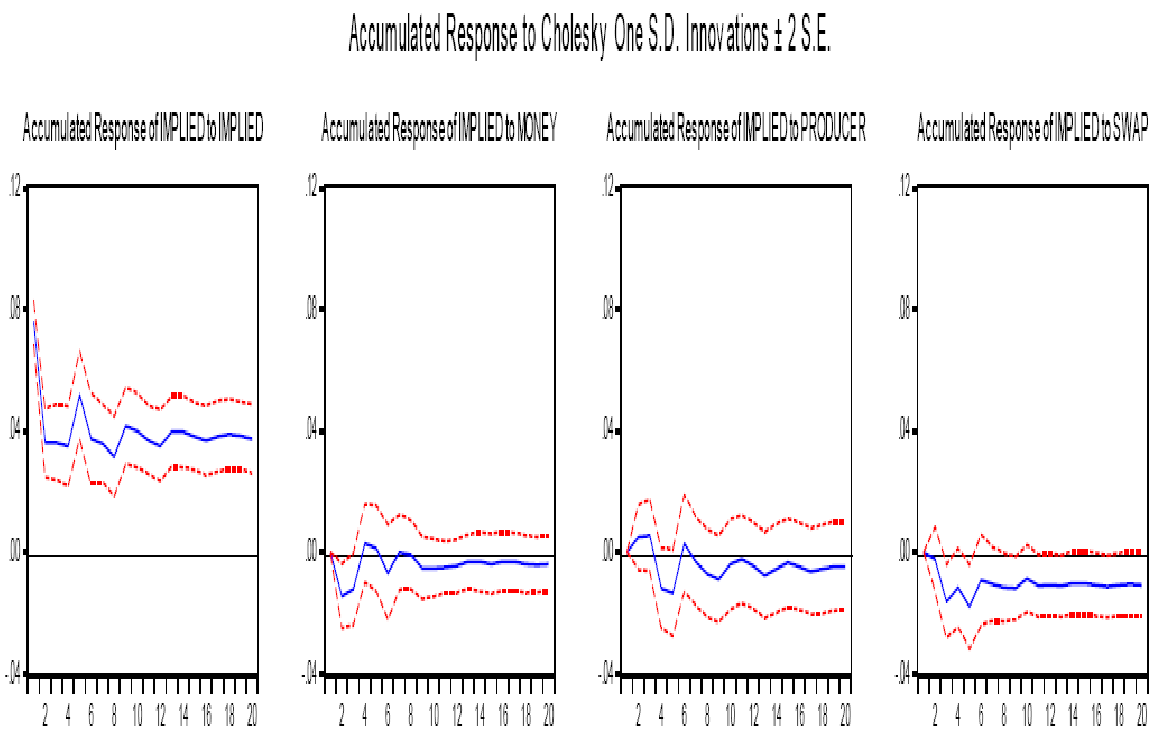
The results show that *producer* activity Granger-causes changes in volatility at the 5% level, while the comparable statistics for *money managers* and *swap dealers* are marginal. If taken jointly, the three classes Granger-cause changes in implied volatility.

Table 4: Granger causality test

	Δ net position NGC Δ σ	Δ σ NGC Δ net position
Money managers	0.0605	0.2684
Producers	**0.0002**	**0.0010**
Swap dealers	0.0513	0.6142
All	**0.0000**	

Note: the table reports the p-values of the Granger non-causality test between changes in the implied volatility and changes in investor net position. The null hypothesis of the first column is that changes in investor net positions do not Granger cause changes in implied volatility, whereas in the second column the null hypothesis is that changes in implied volatility do not Granger cause changes in investor net positions. The model is a 4 variables VAR(5).

Impulse-response function shows how a variable reacts after a positive shock of another one. In this case, we want to see if volatility increases or decreases after a positive shock of investor activity.



We can see that a positive shock of every class of investors lowers implied volatility; this suggests that, when *money managers* impact prices, they do so in a volatility-reducing way[8].

[8] I imposed the following ordering on the variables in the Cholesky matrix: *implied volatility*, *money managers*, *producers* and *swap dealers*. Since the output can differ if the ordering is modified, I tested the same impulse

5 Conditional volatility analysis

Conditional, GARCH-based, volatility measures are backward-looking and complement forward looking implied volatility. I explore the impact of position changes on conditional WTI volatility using a GARCH-X framework. The GARCH equation is

$$\sigma^2_t = \omega + \sum_{i=1}^{p} \alpha_i \varepsilon^2_{t-i} + \sum_{j=1}^{q} \beta_j \sigma^2_{t-j}$$

Unlike previously, I estimate the GARCH-X equation using *money managers, swap dealers* and *producers* position separately, since estimating a GARCH-X equation with several variables could leads to poorly determined outputs. Using one class of investors at a time is also comparable to Granger causality test.

Adding the change in *money managers* net positions to the GARCH equation I estimate, it becomes

$$\sigma^2_t = \omega + \sum_{i=1}^{p} \alpha_i \varepsilon^2_{t-i} + \sum_{j=1}^{q} \beta_j \sigma^2_{t-j} + \sum_{k=1}^{l} \gamma_k \, \Delta\, money_{t-k} \qquad (4)$$

The mean model is an ARMA(2,2), while I model the conditional volatility process with a GARCH(2,2) model.

The estimates show that *money managers* have a significant impact on volatility, and this impact is negative, since *money* coefficients are both negative. I therefore infer that *money managers* tend to be volatility reducing.

Table 5: GARCH-X estimation with *money manager* lagged positions

Variable	Coefficient	p-value
C	0.001463	0.6387
AR(1)	0.566563	0.0000
AR(2)	-0.787093	0.0000
MA(1)	-0.615055	0.0000
MA(2)	0.872851	0.0000

response function changing the ordering: the results were very similar, implying that the choice of ordering is unimportant.

C	0.000313	0.0938
RESID(-1)^2	0.124967	0.0284
RESID(-2)^2	0.130878	0.0345
GARCH(-1)	-0.173721	0.1630
GARCH(-2)	0.799225	0.0000
Δ money(-1)	**-0.016854**	**0.0109**
Δ money(-2)	**-0.016832**	**0.0002**

Note: the table reports the estimation of a GARCH-X model, where the mean process in an ARMA(2,2) and the conditional variance process is a GARCH(2,2) with 2 *money manager* past positions as additional variables.

Performing the same procedure with swap provider positions, again using an ARMA(2,2) plus GARCH(2,2) specification, I find that only one of the *swap* coefficient is significant, but positive. Index investors seem to be volatility increasing in this case. This result goes in the opposite direction from that of the implied volatility tests.

Table 6: GARCH-X estimation with *swap dealer* lagged positions

Variable	Coefficient	p-value
C	0.001272	0.5645
AR(1)	0.495699	0.0000
AR(2)	-0.851761	0.0000
MA(1)	-0.544215	0.0000
MA(2)	0.918112	0.0000
C	0.000313	0.0938
RESID(-1)^2	0.152119	0.0120
RESID(-2)^2	0.149278	0.0204
GARCH(-1)	-0.190836	0.0096
GARCH(-2)	0.785842	0.0000
Δ swap(-1)	0.007166	0.5021
Δ swap(-2)	**0.016624**	**0.0049**

Note: the table reports another estimation of a GARCH-X model with 2 *swap dealer* past positions as additional variables. Again, the mean process in an ARMA(2,2) and the conditional variance process is a GARCH(2,2) model.

In the estimation of a GARCH-X model with *producer* activity, none of their past position is significant: commercial operators do not seem to have an impact on conditional volatility (not reported).

6 Conclusions

This paper has reported the impact of different classes of investors on the crude oil futures market. The results show that money managers, often interpreted as hedge funds, had a significant impact on prices. This conclusion follows both from Granger-causality tests and analysis of contemporaneous interactions. The results further show that this impact was volatility-reducing, both in terms of implied and conditional volatilities. The results for swap providers, which include the largest part of the index investor transactions, were less clear.

These results are important in the light of the debate about whether or not speculative activity should be restricted. They indicate that more restrictive measures relating speculative, and in particular to hedge fund activity, could lead to an increase in market volatility, which is the reverse of what policymakers intend.

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