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FUTURES TRADING AND OIL PRICE MOVEMENTS

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In this study we examine the roles of speculative trading and crude oil fundamentals in recent oil price movements. To do this we employ futures prices on light-sweet crude traded on the NYMEX from January 1993 to June 2008. Our preliminary findings, using correlation tests, lends support to the notion that speculators played an important role in the recent rise in prices. However, this evidence might be considered insufficient, on the grounds that any meaningful conclusions must consider the mediating role of demand and supply pressures on crude prices. With this in mind, we employ a partial-equilibrium model that incorporates macro-and oil-related fundamentals. The findings from this model explain between 84% to 93% of oil price movements in the 1990s, as well as in more recent years. Moreover, other factors, including speculative trading in crude oil, generally explain less than 2% of the remaining variation in price movements.

The price of light sweet crude traded on the New York Mercantile Exchange (NYMEX) doubled from $60 in May 2007 to $120 in May 2008 and rose further to about $145 by early July 2008, greatly impacting the cost of living, and by some accounts, contributing to the slowing of the U.S. economy in 2008. Numerous commentators, particularly in the first half of 2008, suggested that speculation was driving the oil price rise. While the popular press appears to focus largely on the rise in crude prices, other important commodities also experienced rapid price increases. Some of these increases took place in commodities for which no futures trading existed. For instance, thermal coal rose from $60 per tonne in May 2007 to $142 in May 2008 and traded at $193 in July 2008. Iron ore increased from $84 in May 2007 to $141 in May 2008 and climbed to $170 by July 2008.[1] Despite the common experience of commodity prices in recent months, the behavior

1. International Monetary Fund, International Financial Statistics Database.

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of crude prices and the activity of speculators in oil futures has come under particular scrutiny.[2]

The primary objective of this paper is to compare the roles of futures speculation and macro- and commodity-level fundamentals in oil price movements.[3] More specifically, we examine the degree to which the apparent relationship between the positions of futures traders and crude prices is explained by demand and supply conditions for crude over the period January 1993 to June 2008. As it so happens, when these variables are "mixed" with variables such as proxies for U.S. and Chinese demand, we are able to explain a great deal of the contemporaneous price movements. Our findings generally absolve futures speculation in the price hike noted between 2007 and 2008. The commodity-level variables and the macro variables explain the vast majority of price movements throughout the sample period.

While the popular press appears consumed by the importance of oil and provides more-than-wide coverage of topics related to this commodity, such coverage is not matched in the academic literature. With that said, our study should contribute to the literature on commodity price behavior, particularly in two respects. First, there is broad evidence that commodity prices are not well explained by macro variables such as GDP, exchange rates, and interest rates. For instance, Pindyck and Rotemberg (1990) find that macro indicators explain less than 10% of the variation of half of the commodity prices studied. Interestingly, these indicators were most successful in explaining the variation in gold and crude prices (adjusted R^2 of 0.24 and 0.21, respectively). On the other hand, there is some evidence that factors such as weather and supply have a relatively large impact on commodity price behavior. For instance, Ai, Chatrath, and Song (2006) find that market level indicators, such as harvest size and inventories, greatly improved the adjusted R^2 of their price models by about 0.40 on average. The present study offers further inferences on the degree to which crude fundamentals such as supply and consumption explain price behavior.[4]

Second, there is a fair amount of literature on the role of speculative trading on the behavior of prices in both financial and commodity markets. For instance, following the Brady Commission Report (1988) that suggested that large portfolio insurers had sold substantial quantities of stock index futures prior to the October 1987 stock market crash, a host of studies, including Roll (1988), Grossman (1988), and Bessembinder and Seguin (1992), examined the role of futures trading in stock price behavior. Other studies, including Chatrath and Song (1999), examined

2. For example, see Cho (2008), "Transparency Sought as Speculators Activity in Oil Market Grows," *Washington Post*, July 28, p. A07.

3. The commodity-level fundamentals include inventories, production, and consumption. We employ the term fundamentals to distinguish these variables from speculative trading. Their selection represents variables thought to play a role in the dynamics of oil price movements.

4. It is important to note that while our study offers evidence on the degree to which crude fundamentals such as supply and consumption explain price behavior, our motivation is not to establish the determinants of oil prices. Our objective is far more modest. We wish to assess if speculation, vis-a-vis crude oil fundamentals, played an important role in crude-price changes during the period of the study, particularly in recent years.

agricultural commodity markets. The overall evidence from these studies on the destabilizing role of speculators is mixed. On the one hand, several studies find evidence supportive of the role of speculators. For instance, Roll compares the severity of the 1987 crash in 23 major stock markets and finds that markets that did not have derivatives trading experienced as severe a market drop as those that did. Chatrath and Song (1999) examine the potential role of futures speculators and find that while speculative positions increase over their sample period, price jumps did not. Bekaert and Harvey (2000) examine speculative activity within the context of lessening regulation in emerging equity markets. Among their findings is the evidence that following liberalization, and the entry of speculative trading, across a range of specifications the cost of capital consistently declines within a range of 5 to 75 basis points. On the other hand, some findings on the role of speculators are less supportive. Grossman (1988) and Bessembinder and Seguin (1992) indicate that unexpected (unforecastable) levels of futures activity may be destabilizing. The evidence from this study adds to this line of the literature.[5]

The rest of this paper is organized as follows. In Section I we present a partial-equilibrium model that incorporates macro and oil-related fundamentals. In Section II the data are described. In this section, results from preliminary tests, as well as results from tests of the partial-equilibrium model, are also provided. Section III concludes.

I. EQUILIBRIUM MODEL

A. Empirical Implementation

The model we present below is an adaptation of the framework presented in Ai, Chatrath, and Song (2006). We follow their framework for several reasons. First, they develop their model for commodities in general, so that it is easily substituted to crude. Second, their framework employs inventory, production, and net import data to explain price movements for agricultural commodities within a partial-equilibrium framework. This translates well to our analysis. Note that the strong interest in weekly petroleum-supply statistics released by the Department of Energy suggest that these variables are also considered the most important of the observable fundamentals for oil as well. Third, in the Ai et al. model commodity

5. The findings in two other studies are worth noting, since they both provide evidence on the functioning of the crude oil futures market. Specifically, they focus on the relationship between futures and spot prices. Switzer and El-Khoury (2007), using data that span the period 1986 to 2005, investigate the efficiency of the NYMEX crude oil futures market during periods of extreme conditional volatility. Their findings show that futures prices are cointegrated with spot prices, and that they are unbiased predictors of future spot prices. They also find futures and spot prices to exhibit asymmetric volatility, and that hedging performance is improved when asymmetries are accounted for. In another study, Moosa and Al-Loughani (1995), present a model that examines the relationship between spot and futures oil prices, and the role arbitarge and speculation play in that relationship. They test their model with crude data for the years 1986 to 1991. For their sample period they find that arbitarge played a more important role than speculation in determining futures prices.

inventories are endogenous. Such a treatment is also important when modeling crude, where proactive inventory (and overall supply) management is a reality. Finally, Ai et al. circumvent specification error using a semi-parametric framework. This is also important when we model the equilibrium process with crude.

Let p_t represent the price of crude oil at time t, D_t the net demand for the commodity, X_t a matrix of economic indicators, and C_t a matrix of futures positions in the commodity. A general and quite natural approach to assess the role of futures trading in pricing crude would be to compare the explanatory powers of the alternate regressions:

$$p_t = f(D_t, X_t) + u_t, \tag{1a}$$

and

$$p_t = f'(D_t, X_t, C_t) + u'_t, \tag{1b}$$

where u_t and u'_t are the unexplained portion of prices, and f and f' are the functions to be estimated. A carefully selected set of economic indicators making up X are also likely to be informative on the qualitative expectations of future demand, $E(D_{t+k})$ so that they may be thought of as demand shifters. From a reading of the literature on commodity prices, it appears that Industrial Production, the Dollar Index, and a metric of general interest rates are prime candidates for inclusion as economic indicators (see, e.g., Pindyck and Rotemberg 1990; Ai et al. 2006). Further, let z_t represent U.S. production of crude between $t-1$ and t, η_t the net imports of the commodity over the interval, s_t its total supply, and I_t the ending inventories. Then the market clears at:

$$\begin{aligned} D_t + I_t &= s_t \ or \\ D_t &= s_t - I_t, \end{aligned} \tag{2a}$$

with supply given by:

$$s_t = z_t + \eta_t + (1 - \delta)I_{t-1}, \tag{2b}$$

where δ is the per period deterioration rate of inventories.[6] From equations (1) and (2) we have:

$$p_t = f(s_t - I_t, X_t) + u_t, \tag{3a}$$

and

6. While deterioration of inventories would typically be associated with oil spills or refinery fires, one could widen it to include strategic hoarding by state and federal governments. We assume the deterioration rate δ is constant, and drop it from our framework.

$$p_t = f'(s_t - I_t, X_t, C_t) + u'_t, \tag{3b}$$

two partial equilibrium formulations that consider the effects of current and expected demand and supply conditions.

The theory of commodity prices suggests that inventories are endogenous (see, e.g., Williams and Wright 1991; Deaton and Laroque 1992; Chambers and Bailey 1996). For instance, suppliers (refiners) are commonly thought to hoard crude (the products of crude) when prices are expected to rise. In other words, we must estimate net contractual demand and inventory jointly. Therefore, to estimate equation (3), we must (*i*) model the functional form of *f*(.) and (*ii*) address the endogeneity of the inventory variable. To reduce the potential for misspecification error, we adopt the flexible model, similar to that in Ai et al. (2006), as follows:

$$\begin{aligned} p_t = {} & \alpha_0 + \alpha_{1,1}(s_t - I_t) + \ldots + \alpha_{1,n}(s_t - I_t)^m + \\ & \alpha_{2,1}(s_t - I_t)X_t + \ldots\ldots + \alpha_{2,n}(s_t - I_t)^k X_t + \\ & \alpha_{3,1}(s_t - I_t)C_t + \ldots\ldots + \alpha_{3,n}(s_t - I_t)^k C_t + \\ & \alpha_4 X_t + \alpha_5 C_t + u_t, \end{aligned} \tag{4}$$

where the orders of *m* and *k* are determined by the data through a cross-validation approach that is common in the nonparametric literature (e.g., Zhang 1993).[7] The endogeneity of the inventory variable will be addressed by an instrumental variable approach with 1, s_t^2 ,.. , s_t^{m+1} , $s_t X_t$, $s_t^2 X_t$, .., $s_t^{k+1} X_t$, $s_t^2 C_t, \ldots$ $s_t^2 C_t^{k+1}$ as instruments.[8] Equation (4) may be considered a partial-equilibrium model and may be estimated with the variables in their log, level, or first-differenced forms.

II. DATA, STATISTICS, AND EMPIRICAL RESULTS

The empirical analyses are conducted mostly on monthly data from January 1993 through June 2008. Where data availability allows, some tests are also conducted using weekly frequencies.

A. Crude Prices

We follow standard practice by employing futures prices on light-sweet crude that trades on the New York Mercantile Exchange (NYMEX). The futures contract on crude has monthly expiration cycles, and a continuous nearby series (*F*1) is

7. See Ai, Chatrath and Song (2006) for a detailed explanation of the procedure.

8. More specifically, the first stage of the estimation of equation (4) obtains the predicted values of $(s_t - I_t), \ldots\ldots, (s_t - I_t)^m, (s_t - I_t)X_t, \ldots\ldots\ldots (s_t - I_t)^k X_t, (s_t - I_t)C_t, \ldots\ldots (s_t - I_t)^k C_t,$ by regressing each of these variables on 1 , $s_t, s_t^2, \ldots\ldots, s_t^{m+1}, s_t X_t, s_t^2 X_t, \ldots$ $s_t^{k+1} X_t$. These predicted values are then employed on the right-hand side of equation (4).

constructed employing the settlement price on the contract closest to maturity on the last day of the pre-expiration month. Alternate series are constructed for the next-to-nearby contract ($F2$), and third and fourth next-to-nearby contracts ($F3$) and ($F4$).[9]

B. The Traders Positions

We employ Commitment of Traders (COT) data collected by the CFTC that reflect the long and short contractual positions of three important groups of futures traders. Commercial traders are those who have a commercial interest in the commodity (for instance, crude producers, oil refineries, and large oil consumers including those in the airlines industry). They are commonly referred to as large hedgers since their positions exceed some level prespecified by the CFTC, currently at 350 contracts, with each contract calling for delivery of 1,000 barrels of crude. Noncommercial traders do not have a commercial interest in the commodity but also exceed the CFTC reporting levels. They are commonly referred to as large speculators and are the traders currently under scrutiny for their potential role in the rapid rise of crude prices. Small traders are those whose positions do not exceed reporting levels, so that no distinction is made regarding their motive, that is, hedging or speculating.[10]

We employ three measures of trader positions. We define L_t and S_t, respectively, as the number of long and short contracts outstanding. One measure of trader positions that we employ is simply the sum of long and short positions for the i^{th} trader group, $C1_{i,t} = (L_{i,t} + S_{i,t})$. A second measure used is given by $C2_{i,t} = (L_{i,t} - S_{i,t})$, the "net position" for trader group i, and a third measure employed is the "net ratio" for trader group i, given by $C3_{i,t} = \frac{(L_{i,t}-S_{i,t})}{Total}$, where *Total* represents the total number of contracts across all traders. Given our objectives of establishing the role of speculators in the direction of price movements (rather than volatility in price) $C2_{i,t}$ is of particular interest in our analyses.

C. Macro- and Market-level Data

Monthly data on U.S. inventories, production, imports, and exports of crude are obtained from the U.S. Department of Energy. Crude supply for month t is given by the sum of production, net imports and ending inventories for month $t-1$. Crude disposition is given by Crude supplies minus ending inventories for month t. The U.S. macroeconomic indicators — Industrial Production (IP), three month secondary market Treasury bill yield (BR), and the broad dollar index (FXR) — are obtained from the Federal Reserve Bank data files. We also use the index of industrial production for China (*ChinaIP*), obtained from the IMF's International Statistical

9. Price data are obtained from the NYMEX.

10. Changes in the make-up of participants in futures markets in recent years, particularly the entry of investment funds, could render the CFTC classifications of participants and their identification as hedgers, speculators, and small traders, to be less-accurate. We address this issue in the discussion that follows our results, and show that our inferences our robust to these classifications.

Yearbook. It is widely believed that China's economic boom has played a central role in the recent rise in crude prices.

D. Preliminary Results

1. General Patterns and Correlations

Table 1 reports Pearson correlation and Spearman's Rank coefficients of correlation between the differenced monthly prices and futures-holdings series.[11] We present results for the aggregate trader series $C1_{i,t} = (L_{i,t} + S_{i,t})$ in Panel A and for the net trader series $C2_{i,t} = (L_{i,t} - S_{i,t})$ in Panel B. The results are reported for the full sample (1993-2008) and for three sub-samples (1993–1997, 1998–2002, and 2003–2008), and the groups (based on our earlier discussion) identified as Large Speculator, Large Hedger, and Small Trader. We employ Morrison's likelihood ratio test statistic, $-2\ {*}log(\lambda)$ where $\lambda = |d|^{0.5*N}$, $|d|$ is the determinant of the correlation matrix, and N is the sample size, to establish significance for the correlation tests.[12]

The results in Table 1 appear to support the notion that speculation has played a major role in price movements. By far the highest Pearson and Rank correlations belong to the large speculator group. More important to the hypothesis, the correlation pertaining to net long positions of large speculators, shown in Panel B, has been high and tightly range-bound throughout the sample period (both Pearson and Rank correlations fall between 0.54 and 0.50). The correlation between changes to price and net small trader holdings is found to be strong over the 1993–1997 and 1998–2002 intervals. However, the correlation in the most recent interval is weak, seemingly absolving the small-trader group from the recent march in crude prices. The correlation for changes to net large hedger positions is consistently negative.

To further assess these patterns, we plot in Figure 1 the nearby futures price for crude ($F1$) alongside the net contractual obligations of large speculators and large hedgers. The near-mirror image of the two trader positions is an obvious reality of futures markets — that hedging imbalances must be exactly offset by speculative imbalances. As in Table 1, there are indications of a relatively consistent and close relationship between the price and the net speculative position. Especially interesting to the current arguments by policymakers, the net speculator position rose sharply between late 2007 and mid 2008, coinciding with the rise in crude prices. This pattern may be thought to be interesting on another ground: As evidenced in Figure 1, very rarely have prior large imbalances in trader positions in crude persisted for periods of more than a few months.

Table 1 and Figure 1 appear to support the argument that speculators have played an important role in the recent rise in prices. However, this evidence might be considered insufficient on the grounds that any meaningful conclusions must

11. The Rank correlations (displayed in [ ]) are robust to large outlying observations, a common feature in commodity price series.

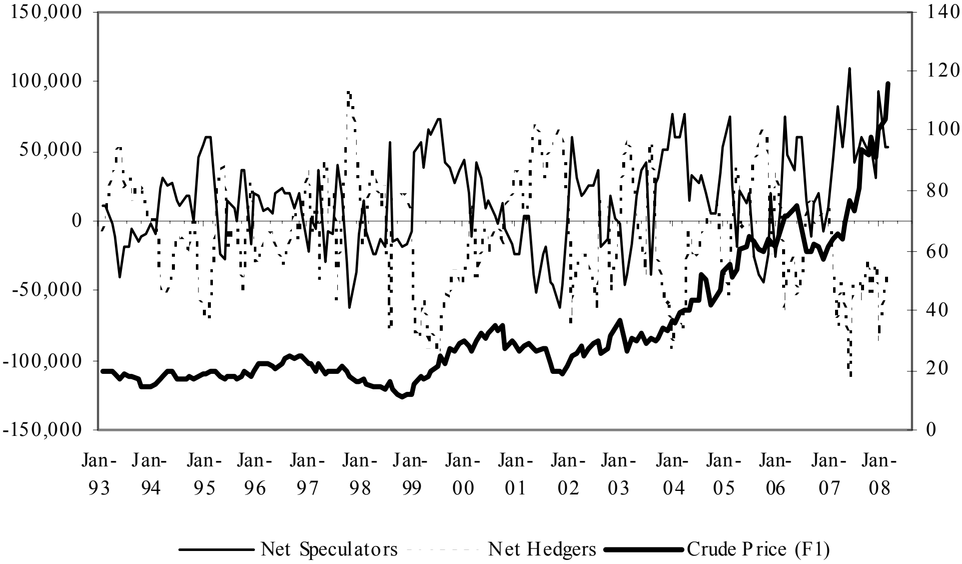
12. For the full sample, the test statistic implies that a correlation coefficient of 0.180 is significant at the five percent level.

Table 1. Pearson and Spearman Rank Correlation Coefficients for Monthly Changes in Crude Price (ΔF1).

	1993-2008	1993-1997	1998-2002	2003-2008
A. Long + Short ΔContracts				
Total (All Traders)	0.180* [0.178*]	-0.014 [0.013]	0.494* [0.424*]	0.066 [0.062]
Large Speculators	0.352* [0.297*]	-0.015 [0.002]	0.408* [0.409*]	0.375* [0.346*]
Large Hedgers	0.010 [0.048]	0.054 [0.069]	0.388* [0.257*]	-0.194* [-0.173]
Small Traders	0.203* [0.150]	-0.142 [-0.145]	0.312* [0.443*]	0.224* [0.188]
B. Long-Short ΔContracts				
Large Speculators	0.489* [0.539*]	0.535* [0.538*]	0.542* [0.526*]	0.501*[0.543*]
Large Hedgers	-0.456* [-0.484*] -	0.534* [-0.570*]	-0.569* [-0.557*]	-0.461*[-0.524*]
Small Traders	0.216* [0.150]	0.427* [0.469*]	0.522* [0.455*]	0.039 [0.064]

Pearson correlations and Spearman Rank correlations (in [ ]) between the differenced monthly prices and futures-holdings series are reported above. The results for the aggregate trader series (L+S) are presented in Panel A, while the results for the net trader series (L-S) are presented in Panel B. The results are shown for the full sample (1993-2008) and three sub-samples. To establish significance, we employ Morrison's likelihood ratio test statistic, $-2*\log(\lambda)$ where $\lambda=|d|^{0.5N}$, where |d| is the determinant of the correlation matrix and N is the sample size. * represents significance at the 5% level.

Figure 1. Crude Prices (F1) and Net Futures Positions: 1/1993-6/2008.



first consider the mediating role of demand and supply pressures on crude prices. Specifically, it can be argued that trader positions (and especially speculator positions) simply reflect fundamental factors, so that the relationship between trader positions and prices would only be a symptom of a proxy effect. We subject these arguments to a set of cointegration tests.

2. Cointegration Results

We conduct tests of cointegration among prices, trader positions, and crude fundamentals using Johansen's (1988, 1991) methodology.[13] Johansen proposes a pair of likelihood ratio tests, the trace test and the maximum eigenvalue test, both standard in the literature (see Johansen (1995) for a detailed description of the tests). Prior to implementing these tests, we test each series for stationarity using Augmented Dickey-Fuller (ADF) statistics (see Said and Dickey 1984).[14] We find evidence that crude prices, crude supply, crude disposition, and aggregate positions (long+short) for speculators, hedgers and small traders each are integrated of order one, $I(1)$; that is, they are nonstationary in their levels and stationary in their first difference. Net hedgers and net small-trader positions are found to be $I(0)$ and net

13. While our main objective is to assess whether speculation has caused crude prices to move (vis-a-vis commodity fundamentals) in the mid to late 2000s, it will be useful to also assess whether there is a long-run relationship between speculative positions and prices, and also whether this relationship may be the result of a long-run relationship between speculative positions and fundamentals. It is also possible that the relationship between speculative activity and prices in the 2000s may have been a manifestation of fast-changing fundamentals for the crude market. Thus within the overall development of the model, cointegration tests allow us to assess whether there is a long-run relationship between speculative positions and prices, and, to some extent, whether this long-run relationship is a result of a proxy-effect.

14. These results are not reported in the interests of brevity but are available on request.

Table 2. Johansen's Tests for Cointegration: 1/1993-6/2008.

A. Cointegration with F1

	Crude Disposition		All Trader Contracts		Large Speculator Total Contract		Large Hedger Total Contracts		Small Trader Total Contracts	
	J_{trace}	J_{max}	J_{trace}	J_{max}	J_{trace}	J_{max}	J_{trace}	J_{max}	J_{trace}	J_{max}
$r = 1$	2.701	2.701	2.382	2.382	2.083	3.455	1.659	1.659	1.659	
$r = 0$	24.813	22.113**	19.291**	16.909**	19.176**	17.093**	16.185*	14.526*	16.185*	14.526*

B. Cointegration with Disposition

	All Trader Contracts		Large Speculator Total Contract		Large Hedger Total Contracts		Small Trader Total Contracts	
	J_{trace}	J_{max}	J_{trace}	J_{max}	J_{trace}	J_{max}	J_{trace}	J_{max}
$r = 1$	0.541	0.541	2.382	2.382	0.239	0.239	3.473	3.473
$r = 0$	17.947**	17.406**	19.291**	16.909**	15.854*	15.615**	13.703	10.230

Prior to implementing the cointegration tests, each series is tested for stationarity using Augmented Dickey-Fuller (ADF) tests (e.g., Said and Dickey (1984). The results from the ADF tests show that crude prices, crude supply, crude disposition, and aggregate positions (long+short) for speculators, hedgers, and small traders, are each integrated of order, I(1), suggesting that these series are nonstationary in their levels but stationary in their first differences. The results for cointegration with crude prices (F1) are presented in Panel A, and with crude disposition in Panel B. Critical values are obtained from Johansen and Juselius (1990), and are as follows- 95% confidence: 8.1 (r=1) and 17.8 (r=0) for the trace test, and 8.1 (r=1) and 14.6 (r=0) for the maximum eigenvalue test; 90% confidence: 6.7 (r=1) and 15.6 (r=0) for the trace test, and 6.7 (r=1) and 12.8 (r=0) for the maximum eigenvalue test. Lag lengths for the tests are based on the Akaike information criterion, and both, a constant and a deterministic trend are allowed in the cointegration tests. * and ** represent significance at the 10% and 5% levels, respectively.

speculator positions appear near $I(0)$.

Table 2 reports the results for cointegration with crude prices ($F1$) in Panel A, and with crude disposition in Panel B for the variables that are pretested as $I(1)$. In Panel A, both tests reject the null of zero cointegrating vectors ($r = 0$) with Disposition. Neither test can reject of the null of one cointegrating vector ($r = 1$) so that there is no support for $I(0)$ for the variables in the system. Based on the results for $r = 0$ and $r = 1$, we conclude that there is a cointegrating relationship between crude prices and disposition of crude. Similar evidence on cointegration is found for $F1$ and total contracts, $F1$ and large-speculator contracts, $F1$ and large hedger contracts, and $F1$ and small trader contracts.

The results in Panel B are for cointegration between disposition and trader positions. Both tests reject the null of no cointegrating vectors, $r = 0$, for disposition and all trader positions, large speculators, and large hedgers. The evidence on cointegration is the weakest for the positions of small traders. In general, based on the evidence in Panels A and B, it is reasonable to conclude that net trader positions are not just related to prices but also to net demand conditions. Therefore, the results appear to provide preliminary support for the fundamentals or proxy arguments, in that prices appear to have a long-run relationship to fundamentals, not just to the positions of traders.

E. Performance of the Equilibrium Model

In Table 3 we report the results from the 2SLS estimation of equation (4) with and without trader positions.[15] We show results for the level series given the strong evidence of cointegration among the key variables of prices, product disposition, and trader positions. The results for differenced, log- and/or seasonally-filtered series do not alter our conclusions.

A cross-validation approach indicate an optimal m and k of 4. In the interests of brevity, Panel A reports results from the most parsimonious version of $m = k = 1$. Panel B reports the explanatory power of this model for futures prices farther away from expiration(i.e., $F2$, $F3$, and $F4$). Panel C shows that the explanatory power of the model improves monotonically as we consider $m = k = 1, \dots, 4$.

The results in the first column of Table 3 (see Panel C) indicate that the model, without considering the positions of futures traders, explains as much as 93.5% ($R^* = 0.935$) of the variation in prices. Each variable and its product with disposition is found to be important to crude prices. As expected, the explanatory power of the model is greatest for the farthest maturity.

The second column pertains to the model that includes net (long-short) positions of speculators and small-traders. Notice that none of the estimations shown in the second column represent an improvement over the estimations shown in the first column. Also notable is the finding that no coefficients pertaining to trader positions or cross-products with crude disposition are significant. Thus, it appears that net

15. Given the endogenous nature of inventories (for commodities), we employ 2SLS. In this respect, we also follow earlier work. See, for example, Ai et al. (2006), who also employ 2SLS.

Table 3. Semi-parametric Estimation of Crude Prices.

	Est. without Futures Positions	Est. with Net Positions (long–short)	Est. with Aggregate Positions (long + short)
A. m = k =1			
Disposition	0.0018*(2.03)	0.0019* (2.14)	0.0015 (1.62)
Dispos x US IP	$0.18x10^{-4}$ (1.84)	$0.12x10^{-4}$ (1.10)	$0.13x10^{-4}$ (1.59)
Dispos x China IP	**$-0.12x10^{-5*}$(-2.51)**	**$-0.12x10^{-5*}$(-2.18)**	**$-0.29x10^{-7}$(-0.03)**
Dispos x Dollar	$-0.33x10^{-4*}$(-2.77)	$-0.28x10^{-4*}$(-2.26)	$-0.25x10^{-4*}$(-2.52)
Dispos x R	-0.00013*(-3.58)	-0.00013*(-3.43)	$-0.81x10^{-4*}$(-2.23)
US IP	-8.664* (-2.02)	-6.042 (-1.31)	-6.426 (-1.71)
China IP	**0.656* (2.98)**	**0.641* (2.60)**	**0.089 (0.23)**
Dollar	15.220* (2.79)	12.904* (2.32)	11.400*(2.52)
Treasury Bill Rate	62.070* (3.66)	59.861* (3.51)	39.760*(2.39)
Dispos x Speculators	–	$0.59x10^{-9}$ (1.24)	$0.12x10^{-8}$ (0.68)
Dispos x Small-traders	–	$-0.76x10^{-8}$ (-1.35)	$-0.44x10^{-10}$ (0.03)
Dispos x Hedgers	–	–	$-0.89x10^{-9*}$(-2.31)
Speculators	–	-0.00019 (-0.16)	-0.00048 (-0.58)
Small Traders	–	0.0033 (1.32)	-0.00010 (-0.12)
Hedgers	–	–	0.00039*(2.26)
R*	0.840	0.838	0.875
B. Summary results for alternate price measures, m=k=1			
R*(F2)	0.862	0.860	0.887
R*(F3)	0.876	0.873	0.895
R*(F4)	0.888	0.883	0.902
C. Summary results for higher orders of m and k			
R^**(m=k=2)*	0.894	0.887	0.911
R^**(m=k=3)*	0.921	0.919	0.927
R^**(m=k=4)*	0.935	0.925	0.941

The results are from the 2SLS estimation of (4). Results in Panels A and B are for curtailed model with no polynomials. Results in Panel C are for the optimum model. Predicted values from the three estimations in Panel C are shown in Figure 2. R^* is defined as 1 minus the unexplained proportion of the total variance. Figures in () are t-statistics. * represents significance at the 5% level.

positions for speculators and small traders do not explain price movement beyond what is explained by crude fundamentals.

The final column reports results for the estimation that includes aggregate (long+short) positions of speculators, hedgers and small traders. The explanatory power of this model is marginally higher than the one that does not consider trader positions. The R^* in Panel C is 0.941, only 0.006 higher than the corresponding R^* in the first column. The coefficients on hedger positions are significant. Interestingly, the traders positions appear to be an unusual proxy for Chinese economic activity. (The introduction of trader positions reduces the coefficient on the variables representing China's industrial production.)

In Table 4 we report the explanatory power of equation (4) over three subsamples between 1993 and 2008. Given relatively small sample sizes, we estimate

Table 4. Explanatory Power of Fundamentals over Time.

	Est. without Futures Positions	Est. with net Futures Positions	Estimation with Total Futures Positions
1993 – 2008	0.840	0.838	0.875
1993 – 1997	0.570	0.662	0.575
1998 – 2002	0.860	0.894	0.874
2003 – 2008	0.892	0.888	0.941

The table reports the explanatory power of the 2SLS estimation of (4) with m=k=1 over four sample intervals. The explanatory power, R^*, is defined as 1 minus the unexplained proportion of the total variance. The results are reported for the full sample (1993-2008) and three sub-samples.

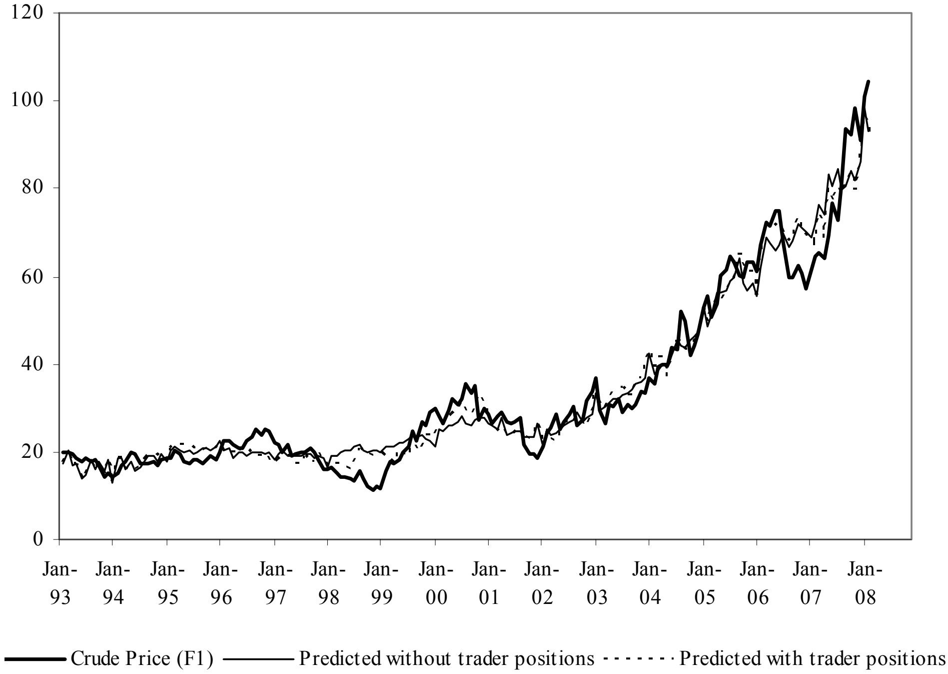
(4) using the most parsimonious form (i.e., $m = k = 1$). Contrary to the argument that the activity of speculators has led to the recent volatility in prices, the results show that fundamentals explain more of the variation in prices after 2003 than in the 1990s. For instance, the R^* pertaining to the fundamentals-only estimation (first column) increases sharply from 0.570 in 1993−1997 to 0.892 in 2003−2008. The results in the other two columns further show that trader positions added more to the explanatory power of the model in the early 1990s as compared to the more recent intervals. In general, the results strongly favor the argument that the recent price movements are more the result of changes to fundamental factors rather than to futures trading activity alone.

These findings are further highlighted in Figure 2, which shows crude prices alongside the predicted values of the 2SLS estimations using $m = k = 4$ with and without net-trader positions. The two predicted series appear to track the price series equally well. It is noteworthy that the rapid rise in prices seen in 2007 and 2008 are also reasonably tracked by both estimations. That is, it appears that trader positions do not explain the recent rise in crude prices.

F. Discussion

It is justifiable to note the drawbacks associated with the CFTC's Commitment of Traders (COT) data, that is employed in this study, particularly in more recent years. While our interpretation of the data is in keeping with usual practice, the recent growth in investment fund activity in commodity indices may not be adequately captured by the trader designations in the COT data. Furthermore, structural breaks in the data are likely. With that said, both issues are addressed either directly or indirectly in our study. Note that the overwhelming evidence that fundamentals play a large role in explaining the variation in prices — for example, in the model without considering the positions of futures traders, as much as 93.5% of the variation in prices is explained — suggests that CFTC trader identification is almost a non-issue. Also, futures trading in crude oil generally explains less than 2% of the remaining variation in price movements. The issue of structural breaks is directly addressed by our sampling of three different sub-periods, in addition to the full sample.

Figure 2. Actual versus 2SLS-predicted Prices.



III. CONCLUSIONS AND IMPLICATIONS

The recent rise in crude prices has created concern among consumers, politicians, market-participants, and regulators. A large part of the blame appears to be directed at speculators, who are accused of playing a large role in this price run-up. Given these concerns, in this study we focus not only on the effects of fundamentals on the price formation process in crude markets, but also on the potential role of speculative activity.

Our study is two-pronged. In the first stage we assess general trends between oil price movements and trading activity. Simple correlation tests, using a likelihood ratio statistic, provide findings that lend support to the argument that speculators played an important role in the recent rise in prices. However, drawing robust inferences from such an examination is subject to criticism; such evidence might be considered insufficient on the grounds that any meaningful conclusions must first consider the mediating role of demand and supply pressures on crude prices. Specifically, it can be argued that trader positions (and especially speculator positions) simply reflect fundamental factors that influence crude prices, such as inventories, so that the relationship between trader positions and prices would only be a symptom of a proxy effect. With this in mind, we subject these arguments to a set of cointegration tests. We examine cointegration among prices, trader positions, and fundamentals using Johansen's (1988, 1991) methodology. Based on the evidence from these tests, we find it reasonable to conclude that net trader positions are not just related to prices but also to net demand conditions. Therefore, the results appear to support the fundamentals or proxy arguments, in that prices appear to have a long-run relationship with fundamentals, not just to the positions of traders.

In the second stage, we conduct an in-depth semi-parametric analysis using a partial-equilibrium model. We find with the model that, without considering the positions of futures traders, as much as 93.5% of the variation in prices can be explained. When we include net (long-short) positions speculators and net small-traders, none of the estimations represents much improvement over the earlier estimations. Thus, it appears that net positions for speculators and small traders explain little beyond what is explained by fundamentals.

We also conduct tests for three subsamples between 1993 and 2008. We find, contrary to the argument that the activity of speculators has led to the recent volatility in prices, that fundamentals explain more of the variation in prices after 2003 than in the 1990s. The results also show that trader positions add more to the explanatory power of the model in the early 1990s as compared to the more recent intervals. In general, the results strongly favor the argument that the recent price movements are more the result of changes to fundamental factors rather than to futures trading activity alone.

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