Oil price volatility and speculation

Stein-Erik Fleten, Mats Olimb[1] and Tore Malo Ødegård

Norwegian University of Science and Technology, NO-7491 Trondheim, Norway

Abstract

This paper presents a comparison of crude oil price volatility and trading activity compared to other commodities and across two time periods. Economists and policy makers have shown signs of increased concerns regarding excessive speculation and volatility in the crude oil market in recent years. We examine different aspects of price volatility for two marker crude oils and eleven other widely traded commodities. Crude oil prices are found to be in the upper range of all measures of price volatility in the period from 1994-2002, consistent with Plourde & Watkins (1998), but not significantly higher than most commodities in the 2003-2009 period. Price movements in all commodities have become more correlated in recent years. We also show that the increased trading activity is not unique for the crude oil market, and that speculative positions display a significant relationship with price changes and volatility for most NYMEX-traded commodities studied.

[1] Contact author: Mats Olimb, Department of Industrial Economics and Technology Management, Norwegian University of Science and Technology, NO-7491 Trondheim, Norway, email: mats.olimb@gmail.com, ph: +47 93408794

1 Introduction

Crude oil price volatility and speculation has been given additional attention as a result of the extreme movements seen the recent years. Crude oil prices rose almost 500 percent from 2003 to mid-2008, thereafter it suddenly dropped almost 80 percent, before gaining nearly 150 percent in ten months. Daily price movements have been as large as, and above, 15 percent for several days. As a consequence, oil price speculation has entered the shed of light of policy makers on both sides of the Atlantic. In an opinion piece submitted to the Wall Street Journal (Brown & Sarkozy, 2009) U.K Prime Minister Gordon Brown and French President Nicolas Sarkozy wrote that governments need to act to curb a "dangerously volatile oil price" that defies "the accepted rules of economies". In the United States the Commodity Futures Trading Commission (CFTC), the main U.S futures markets regulator, is considering tougher regulation of oil futures market. This has led to a notion that volatility and speculative positions are especially high in the crude oil market. The speculators role in the market remains controversial, but there is limited statistical research on how volume of speculative trading in commodity derivatives may impact prices and volatility. The reason is most likely due to the lack sufficiently detailed data on market positions.

In the last 6-7 years there has been a significant growth in the commodity derivatives markets. The total value of the investment in commodity indexes has increased from about $15 billion in 2003 to above $200 billion by mid-2008 (Permanent Subcommittee on Investigations, 2009). During this period, financial institutions have heavily marketed commodity indexes as a way to diversify portfolios and profit from rising commodity prices. About 70 percent of the commodity index investments are invested in near-term energy contracts, following a strategy of continuously rolling futures contract to maintain the investment (Hamilton, 2008). This strategy can be implemented simply via the futures market, but also via the unregulated swaps market or through mutual funds, exchange traded funds (ETFs), exchange traded notes (ETNs) or other hybrid securities.

The growing consensus in the U.S Congress that speculators may be distorting prices, does not only take roots in the derivative market growth, but also the increasing share of financial institutions that do not use the commodity as a part of their business. A question, which is being continuously discussed, is how large the market presence of speculators should be to facilitate the smooth operation of the markets, and whether excessive speculation has any effect on the market price and price volatility. The term excessive speculation is mentioned already in the Commodity Exchange Act (CEA) from 1936; "Excessive speculation… causing sudden or unreasonable fluctuations or unwarranted changes in the price..." (CEA, 1936). The concern is that if the speculators are dominant in the market, and a speculative euphoria takes hold, self-reinforcing price cycles may take place, where speculative flows of money drive prices and these price movements can attract more speculative money. The result would be high volatility and uncertainty for physical producers and consumers.

In this paper we study dispersion of price changes and volatility across different commodities in the US and UK futures market. Specifically we investigate whether there exists any significant differences in volatility and volatility developments from 1994 to 2009, in crude oil compared to other commodities. In general, there is limited research regarding oil volatility compared to other commodities in recent years. A common belief, however, is that since the 1973 oil crisis, oil and energy prices in general, have been more volatile than other commodity prices (Fleming & Ostdiek, 1999). Plourde & Watkins (1998) found that crude oil price volatility during the 1985-1994 period was in the upper end of the range of all measures of price volatility studied, but was not "clearly beyond the bounds set by other commodities". In another study Andrew Clem (1985) analyzed commodity volatility trends using 156 producer price indexes during 1975-84, and found that crude oil and coal was less volatile than agricultural and primary metal commodities. Eva Regnier (2006) examined monthly producer prices for a broad set of products in the United States over the period 1945-2005, and found that crude oil and natural gas was more volatile than prices for about 95 percent of products. Relative to other crude commodities, however, crude oil was only significantly more volatile than 60 percent of the crude series.

To address the question of crude oil volatility compared to other commodities we follow the work of Plourde & Watkins (1998) and extend their work by adding some commodities and analyze new data sets. An addition to their study is that we divide our time series into two periods, to examine the effect of shifts in open interest and volatility after the implementation of The Commodity Modernization Futures Act of 2000. With respect to Clem (1985) findings, we have included metals and agricultural commodities in our volatility study, along with the energy commodities natural gas and coal. The notion of price volatility has several dimensions. In the same manner as Plourde & Watkins (1998) and Regnier (2006) we investigate differences in log-returns and absolute rates of return across commodities, and across the time periods. A surprising finding is that crude oil volatility has not increased significantly between the two time periods and not as much as the other commodities.

Further we investigate trading activity and speculative positions in crude oil compared to other commodities. While there are limited statistical studies regarding the relationship between trading activity and volatility in commodities, several studies have examined the empirical relationship in the equity market. For example, Bessembinder & Seguin (1993) found that that open interest has significant negative effect on volatility, while trading volume has a significant positive effect.

In the context of commodities Fleming & Ostdiek (1999) conducted a study based on daily spot prices and total open interest across all NYMEX[2] crude oil contracts lengths from 1982 to 1997 using public CFTC data. In conformity with Bessembinder & Seguin (1993), they found a negative relation between open interest and volatility, and suggested that futures trading stabilize the market as trading improve depth and liquidity. Verleger (2009) found in his studies no correlation between WTI[3] crude oil price and flows of money into the WTI futures contracts offered by the Intercontinental Exchange (ICE) and NYMEX. Nor did he find any correlation between crude oil prices and flows of money in or out of commodity index funds, which constitute the larger part of the speculative investments. Dufour & Engle (2000) suggested that large volume of purchases might well cause price to increase, at least

[2] New York Mercantile Exchange.
[3] West Texas Intermediate.

temporarily, until the investors have the chance to verify the true fundamentals. If there is a considerable difference in volume on either buy or sell side, potential investors may take this as a possible signal that there is something they don´t know, and hence buy or sell contracts not based on fundamental information. This may result in time periods with additional volatility, and as more speculators are entering the market it is reasonable to believe that the frequency of such time periods increases.

Some work is conducted in cooperation with CFTC and utilize non-public datasets based on the CFTC Large Trader Reporting System (LTRS) to examine the role of hedgers and speculators in the commodities markets. Among these studies are Haigh et al. (2007) which conclude that hedge fund activity does not affect price levels in energy futures markets, and that speculators are providing liquidity to hedgers and not the other way around. Irwin & Holt (2004) show a small but positive relationship between trading volume and volatility.

Similar to Bessembinder & Seguin (1993) and Fleming & Ostdieks (1999), we will use open interest as a measure of trading activity. We use public data from CFTC to examine open interest; total and speculative positions, in the futures market, and investigate whether there are significant differences between the commodities studied. The CFTC data is used to study the relationship between price volatility and market positions. We find that speculative positions do have a significant impact on price movements, but the result is not exclusive for the crude oil market.

To structure our study of crude oil prices and trading patterns compared to other commodities we have developed the following hypotheses which we will seek to reject or verify in the following sections. We will examine how the changes in futures market regulations (CFMA) and the start of OTC trading on crude oil have changed the volatility and trading activity in the crude oil futures compared to that of other common commodity futures and how this affects the underlying spot market.

H1. Crude oil prices are more volatile than other commodities. This has been a common belief since the 1973 oil crisis when oil markets experienced extreme volatility. In the last years we have witnessed an increased focus on crude oil price volatility in economic and politic circles.

H2. Crude oil price volatility has increased significantly from the time period before and after the implementation of CFMA. The CFMA of 2000 made sweeping changes to the way energy futures markets were being regulated. The act exempts most over-the-counter energy trades and trading on electronic energy commodity markets from government regulations.

H3. Open interest has increased more in crude oil than other commodities. The demand for hedging is relatively larger in crude oil products than for other commodities, because of lack of substitutes. The amount of speculative money has also increased considerably.

H4. The proportion of speculators as part of total open interest has increased more for crude oil than for other commodities. Crude oil index funds are among the most popular commodity index funds, which have increased an estimated tenfold in the last six years. Index fund managers will offset their risk in offsetting positions in the derivatives market.

H5. There is a significant relationship between price volatility and the open interest in the futures market and the ratio of speculative traders. Related research results diverge, but the increased focus on this topic the last years leads to this suspicion. Speculators have increased their positions the last years and trade more frequently than hedgers. This could lead to an increased influence on prices movements.

The rest of the paper is organized in the following way. In section 2 we describe different aspects of the futures market and characteristics of the commodities studied. Section 3 describes the data used in our analysis. In section 4 we describe the methodology, tests and results from our empirical research. Conclusions and discussions concerning of the questions and hypotheses raised are presented in section 5.

2 Futures market and commodity characteristics

2.1 Roles in the market

Futures markets make it possible for the hedgers who want to manage price risk to transfer that risk to the speculators who are willing to accept it. Futures also provide price discovery; information that the world looks to as a benchmark in determining the value of a particular commodity a given day and time (Pennings, 1998). The relationship between the futures market's ability to fulfill the social function of price discovery and the possibility of hedging is crucial. We focus on two roles in our analysis, referred to as; hedgers and speculators, or commercial and noncommercial traders by the CFTC.

A hedger is a trader who enters the futures market in order to reduce a preexisting risk. If a trader trades futures contracts in commodities in which he or she has no initial position, and which he or she does not contemplate for taking a cash position, then the trader cannot be a hedger. The futures transaction cannot serve as a substitute for a spot market transaction (Kolb & Overdahl, 2006).

Position traders are speculators who maintain a futures position overnight and over longer period of time. There are two types; outright position traders and spread position traders. It is mainly the position traders' positions that will be reported to the CFTC.

2.2 Regulations of future markets

Futures market regulators are designed to assure the economic utility of the futures markets by encouraging their competitiveness and efficiency, protecting market participants against fraud, manipulation, and abusive trading practices. Regulators should also make sure that the futures markets serve the important function of providing a means for price discovery and offsetting price risk. In the US, the Congress created the Commodity Futures Trading Commission (CFTC) in 1974 as an independent agency with the mandate to regulate commodity futures and option markets in the United States and to administer the Commodity Exchange Act (CEA) of 1936 (CFTC, 2009).

The agency's mandate has been renewed and expanded several times since then, most recently by the Commodity Futures Modernization Act (CFMA) of 2000. The CFMA of 2000 made sweeping changes to the way futures markets were being regulated. Two of the key features in the Act of 2000 are; promoting competition and innovation in the future markets and allowing exchanges to bring new contracts to market without prior regulatory approval. Because the law was new, detailed rule marking and interpretations were required before it could be fully implemented. As a result, many of its key features took a few years to be implemented.

While the U.S markets are regulated by CFTC, the London-based futures exchanges are under jurisdiction of the U.K Financial Services Authority (FSA). Regulation of the markets is largely carried out by the exchanges itself, while FSA are responsible for regulating the financial aspects of the exchange and its participants business. Since a large share of the trading occurs internationally and with U.S linked futures and options, most of the exchanges follow certain directions made by the CFTC and the National Futures Organization (NFA), a self-regulatory organization for the future industry based in the United States.

2.3 Unregulated trading

While futures have to be traded on regulated exchanges, there has over the past decade grown up a market which provides trading of contracts that look very much like ordinary futures but are traded in the unregulated over-the-counter (OTC) market.

In the mid-1990s energy contracts was increasingly being considered as another commodity priced on an open market, and OTC contracts became popular. The increasing number of energy producers, merchants and traders holding these contracts desired to trade these OTC instruments to third parties to help reduce, diversify or spread the risk they have accumulated. In response, the OTC market began to develop standardized OTC contracts that could be traded to multiple parties (U.S. Senate, 2006). This process was boosted by the CFMA in 2000 which permitted clearinghouses to participate in the clearing of OTC derivatives. At the same time the Act removed legal restrictions on OTC contracts that prevented them from being cleared by a central clearing house (Kolb & Overdahl, 2006). The Act effectively opened up for more relaxed regulation of risk management products, including index funds and price swaps, setting the stage for a rapid increase in financial players' participation in the OTC markets. The act is particularly important because it designated certain OTC derivatives transaction, including those involving oil, to be outside of the jurisdiction of the CFTC. Thus, the CFMA made it easier for financial players to obviate speculative limits by creating a loophole[4] that exempted certain participants from speculative position limits and other regulations due to their involvement in OTC markets or electronic trading platforms (Medlock & Jaffe, 2009).

There is little publicly available quantitative measure of the extent of speculative trading in the OTC markets, since traders on unregulated OTC exchanges are not required to keep records or file Large Traders Report. There are neither limits on the number of contracts a speculator may hold, no

[4] This is referred to as the "Enron Loophole" and exempts most OTC energy trades and electronic energy commodity markets from governmental regulation.

monitoring by the exchange itself, and no reporting of the amount of outstanding contracts at the end of each day. According to BIS, though, it is reasonable to believe that a large part of the financial hedging, and thus speculative positions, take place in the OTC market (BIS, 2009).

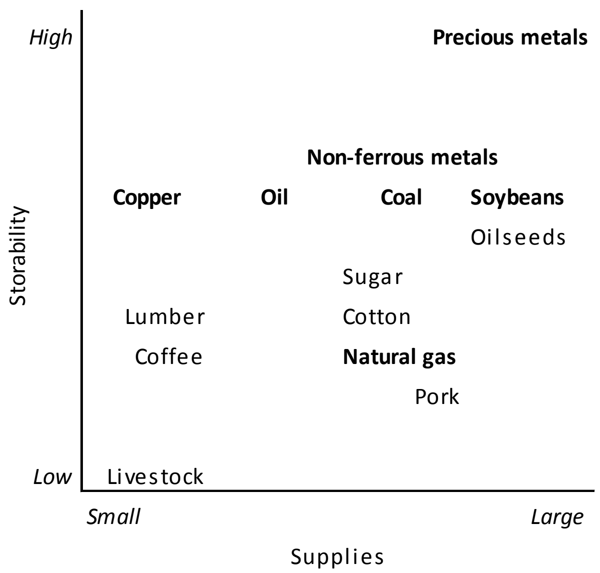
2.4 Price formation and commodity characteristics

When comparing trading activity and price volatility across different commodities, basic commodity characteristics and industry pricing mechanisms should be taken into account. The relationship between the spot and futures price depend upon: transaction costs, the supply of the commodity, the storage characteristics, production and consumption cycle of the good, and the ease of short selling the good. Cash-and-carry arbitrage makes sure that the futures price will move together with the spot price. If the arbitrage link between spot and futures price fails because the physical good cannot be stored, then the futures price is free to rise relative to the spot price (Kolb & Overdahl, 2006).

Here we introduce a brief overview of the differences and similarities between the selected commodities, based on the framework for analyzing price formation developed by Labys (1980). The analysis of commodity prices is normally divided between the long-run price, which can be termed the equilibrium or trend price, and the short-run price, which is associated with speculation and cyclical or random price movements. The concept of price formation investigated here refers to the long-run price and analyzes the market conditions, structure and implications. Key elements are summarized in Table 1.

Figure 1 attempts to capture the relationship between some of these relationships between important commodities and plots the supply storage capabilities of these. The paper focuses on 13 universal commodities, including crude oil (WTI and Brent), coal, natural gas, non-ferrous metals (aluminum, copper, lead, nickel, tin, zinc), precious metals (gold, silver) and soybeans. The commodities are chosen because they possess similarities in their characteristics and price formation. Soybeans are chosen to include a commodity with stricter regulations than seen in WTI.

Figure 1: Supply and storage characteristics



2.4.1 Energy commodity characteristics

WTI is produced and mainly sold in the US market. It has been trading on the NYMEX since 1983, and has been one of the most popular energy contracts. Brent Crude is the biggest of the major classifications of oil and is used to price two thirds of the world's traded crude oil supplies. It has been traded on the ICE (IPE) since 1985, and forms a benchmark for the oil production in Europe, Africa and Middle East. The OPEC has some influence on crude oil prices as the biggest supplier, but prices are set on various exchanges.

Natural gas has lower storable properties than oil and prices may vary across countries and regions. The Henry Hub is the pricing point for natural gas futures contracts traded on NYMEX and offers one of the free markets for trading gas. Coal is the other energy commodity we include and display similar storable properties as crude oil. Prices have been government controlled and linked to electricity prices for some time in Asia and futures only started trading on NYMEX in 2001.

The energy industry is competitive and fragmented, firm sizes vary from very large to small and from vertically integrated to specialized companies. The industry is characterized by large up-front investments and long lead times, although this is not so much the case for coal. The relative storage costs for oil and gas mean that inventory stocks tend to be proportionally smaller for these than other commodities. Changes in inventories can thus play a smaller role in countering oil market disturbances, and are more likely to give rise to short-term price changes. The skewed geographical concentration of fossil fuel reserves, away from the world's main consuming regions, combined relatively high transport costs means that the costs of physical arbitrage will tend to be higher than for other commodities, like gold and silver (Plourde & Watkins, 1998). This might impact price movements in oil to a greater degree than that seen in other commodities.

2.4.2 Non-energy commodity characteristics

In 1987 the London Metal Exchange (LME) underwent a fundamental reorganization, which made trading of non-ferrous metals easier and more competitive. The non-ferrous metals examined are all reasonably homogenous and have a representative price, they are all industrial goods influenced by the level of economic activity, and all are durable and highly storable, which should mean that prices are affected by inventory levels. The production of all is capital intensive and subject to long lead times for development.

Precious metals prices have had virtually single competitive prices set by commodity exchanges for decades. Similarly to non-ferrous metals, development of gold and silver requires considerable up-front investments and is subject to long lead times. Both are highly storable, but subject to lower supply than the other metals.

Soybeans futures have been traded on Chicago Board of Trade (CBOT) since 1980 and are subject to position limits and stricter regulations than other commodities, by the CFTC (as with most agricultural commodities). It is also traded on other exchanges under different contract specifications. There is no centralized spot market for grains like soybeans but exists wherever a buyer meets a seller. Prices are then determined from price discovery in the futures market. Agricultural production does not require large up-front investment and lead times, production is dependent on weather and season, and soybeans are less storable than metals.

All of the commodities examined in this paper are traded on futures exchanges and have been subject to more competitive conditions the last decades. The exchanges are the main pricing mechanism for all. When commodity prices are set by exchanges, parties other than consumers and producers are able to influence prices (Plourde & Watkins, 1998). With the exception of soybeans and coal all commodities require large up-front investments and long lead times for development, industry structures varies in firm sizes and signs of horizontal and vertical integrations and there has been attempts of cartel-like behavior to control price in some commodities. The analysis of volatility should not be influenced by fundamental differences in industry structure, organization and pricing mechanisms to a high degree. All commodities are highly influenced by the overall economic activity. Some differences in market conditions, however, exist and the reader should bear this in mind when comparing price movements across commodities.

Table 1: Commodity characteristics and price formation

	Crude Oil	Natural Gas	Coal	Aluiminum	Copper	Lead	Nickel	Tin	Zinc	Gold	Silver	Soybeans
Market Conditions												
Traded on Exhange	NYMEX, ICE +	NYMEX, ICE +	NYMEX (since 07.2001)	NYMEX, LME	NYMEX, LME	LME	LME	LME	LME	NYMEX, LME +	NYMEX, LME +	CBOT
Supply	non-seasonal	non-seasonal	non-seasonal	non-seasonal	non-seasonal	non-seasonal	non-seasonal	non-seasonal	non-seasonal	non-seasonal	non-seasonal	seasonal
Demand	partly	partly	partly seasonal	non-seasonal	non-seasonal	non-seasonal	non-seasonal	non-seasonal	non-seasonal	non-seasonal	non-seasonal	non-seasonal
Storability	fairly high	low	fairly high	high	high	high	high	high	high	very high	very high	low
Reserves	fairly small	medium	large	fairly large	small	fairly large	fairly large	fairly large	fairly large	large	large	large
Market structure												
Industrial structure	many companies	many companies	many companies	large, vertically integrated companies	independent and integrated companies	independent and integrated companies	a few integrated companies	many small companies	independent and integrated companies	many companies	many companies	many producers, coordinated markets
Market structure	competitive	competitive	competitive	oligopoly, increasingly competitive	increasingly competitive	fairly competitive	oligopoly	fairly competitive	competitive	competitive	competitive	competitive
Producer/price coordination	OPEC		government price control schemes	International Bauxite Ass.	CIPEC			International Tin Council				government price control schemes
Market implications												
Geographical distr. of resources and production	widespread, but concentrated	fairly widespread	fairly widespread (two major producing countries)	widespread	widespread	widespread	widespread	concentrated in Southeast Asia and South America	concentrated in Southeast Asia and Americas	concentrated, but widespread	concentrated, but widespread	concentrated in Asia and Americas
Large up-front investment and lead time?	yes	yes	partly	yes	yes	yes	yes	yes	yes	yes	yes	no
Production capacity	limited	limited	not very limited	limited	very limited	limited	limited	limited	limited	very limited	very limited	not very limited
Durable good?	no	no	no	yes	yes	yes	yes	yes	yes	yes	yes	no
Industrial good?	yes	no	no	partly	partly	yes	yes	yes	yes	partly	partly	no
Price formation												
Pricing mechanism (prices set how)	commodity exchanges	commodity exchanges, also been linked to oil prices in some instances	government controlled, linked to electricity, recently by market forces	prices linked to LME, but prices has also been set by majors	prices set on LME and NYMEX	prices set on LME	prices set on LME	prices set on LME	prices set on LME	commodity exchanges	commodity exchanges	prices set on CBOT

Sources: Labys (1980)

USGS - United states Geological Survey

Mining in Africa today - Strategies and prospects, general editor: Samir Amin

3 Data

3.1 Commodity prices

Daily and average monthly closing spot prices in USD have been collected from the Reuters EcoWin database to compare price movements of crude oil WTI (NYMEX) and Brent (North Sea, Dated) with a set of other commodities. The set consists of 11 other commodities, including; natural gas (Henry Hub), coal (FOB Richards Bay), aluminum, copper, lead, nickel, zinc, tin, silver, gold and soybeans. All non-ferrous metals reflect LME settlement prices and precious metal prices reflect daily settlement prices on NYMEX. For soybeans we use the closest-to-delivery future price on CBOT. Under the assumptions of the cost-of-carry model the price movements seen in spot markets should be reflected in the closest-to-delivery futures prices, and vice versa. The data gathered represent daily and average monthly quotations from January 1st 1994 to October 31st 2009.

The data have been split to study the effect of significant market implications and to avoid asymmetries in price movements. The first time period elapses from January 1st 1994[5] to December 31st 2002 and the second period from January 1st 2003 to October 31st 2009.There are several reasons for this. First, the CFMA of 2000 made sweeping changes to the regulation of the American futures markets, but some time lag was seen before new rules and contracts could be implemented. Second, ICE started futures trading for Brent oil in 2001, and WTI in 2006. Third, after the implementation of CFMA the open interest in futures markets increased rapidly. Finally, commodity prices are affected by economic activity and hence the data have been split so that they both contain an economic expansion, a recession and the start of a recovery.

Price levels for all commodities are found to be non-stationary, checking for unit roots using the Augmented Dickey-Fuller (ADF) test. To avoid problems with non-stationary means and variances and measurement units in price changes, we will focus our analysis on period-to-period log price return *r(t)*.

$$r(t) = \ln \frac{P_t}{P_{t-1}}$$

Daily and average monthly log-returns are calculated for each commodity price series, P_t. Daily return data exhibit sharp spikes and are affected by a great degree of noise and we will primarily use the monthly data as a basis for our analysis and use the daily data as a verification of our results. To illustrate the pattern of these returns, plots for a selection of the commodities are shown

[5] Quotations for Henry Hub Natural Gas starts in November 1993, so we start our analysis form the beginning of 1994. This is also the end mark of the volatility analysis done by Plourde and Watkins (1998).

in Figure 2 and Figure 3 for daily and monthly rates of return respectively. Table 2 shows information and descriptive statistics on the monthly price changes.

All price series display relatively sharp price spikes and sharp reductions. There seem to be some asymmetry in the price changes with large negative spikes and smaller more frequent positive movements. Volatility clustering is visible in the daily returns over shorter intervals. There are no clear trends in the data, however the price changes seem to have increased somewhat during the whole sample period.

The probability value of the Jarque Berà test statistics indicates that returns for all commodities are non-normally distributed using daily quotations. Average monthly returns will display more Gaussian behavior because of averaging, but most commodities have heavy-tailed distribution and negative skewness, especially in time period two. According to the ADF test results, we find that the daily and monthly returns are governed by an *I(0)* process, i.e. they are stationary.

Examining standard deviations in Table 2 for the two time periods we find both Brent and WTI in the upper range with natural gas displaying the highest fluctuations. The largest monthly movements are also found in natural Gas, with crude oil in the upper range of the set, although not so pronounced as with standard deviations. The standard deviation of price returns appears to be slightly higher in the second period for most commodities. Examining the absolute returns in both time periods we again find crude oil displaying some of the largest values, only exceeded by natural Gas. We observe that the mean and median returns are consistently higher in the second time period when compared to the first for most commodities. Time period two has seen the most extreme movements (maximum and minimum) in prices for crude oil. The same trend is seen for most other commodities.

Figure 2: Daily rates of return, 1994 to 2003

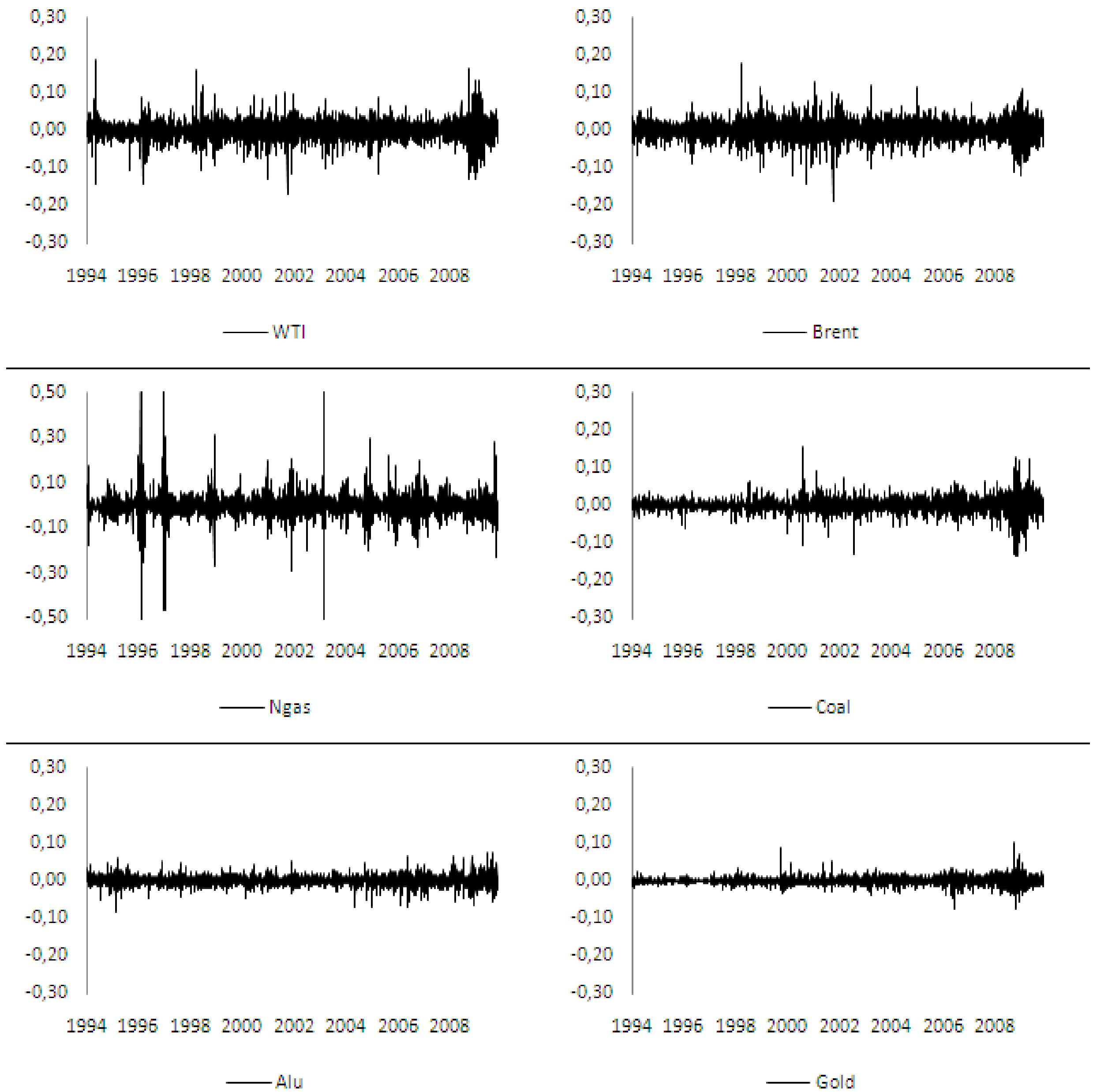


Figure 3: Monthly rates of return, 1994 to 2009

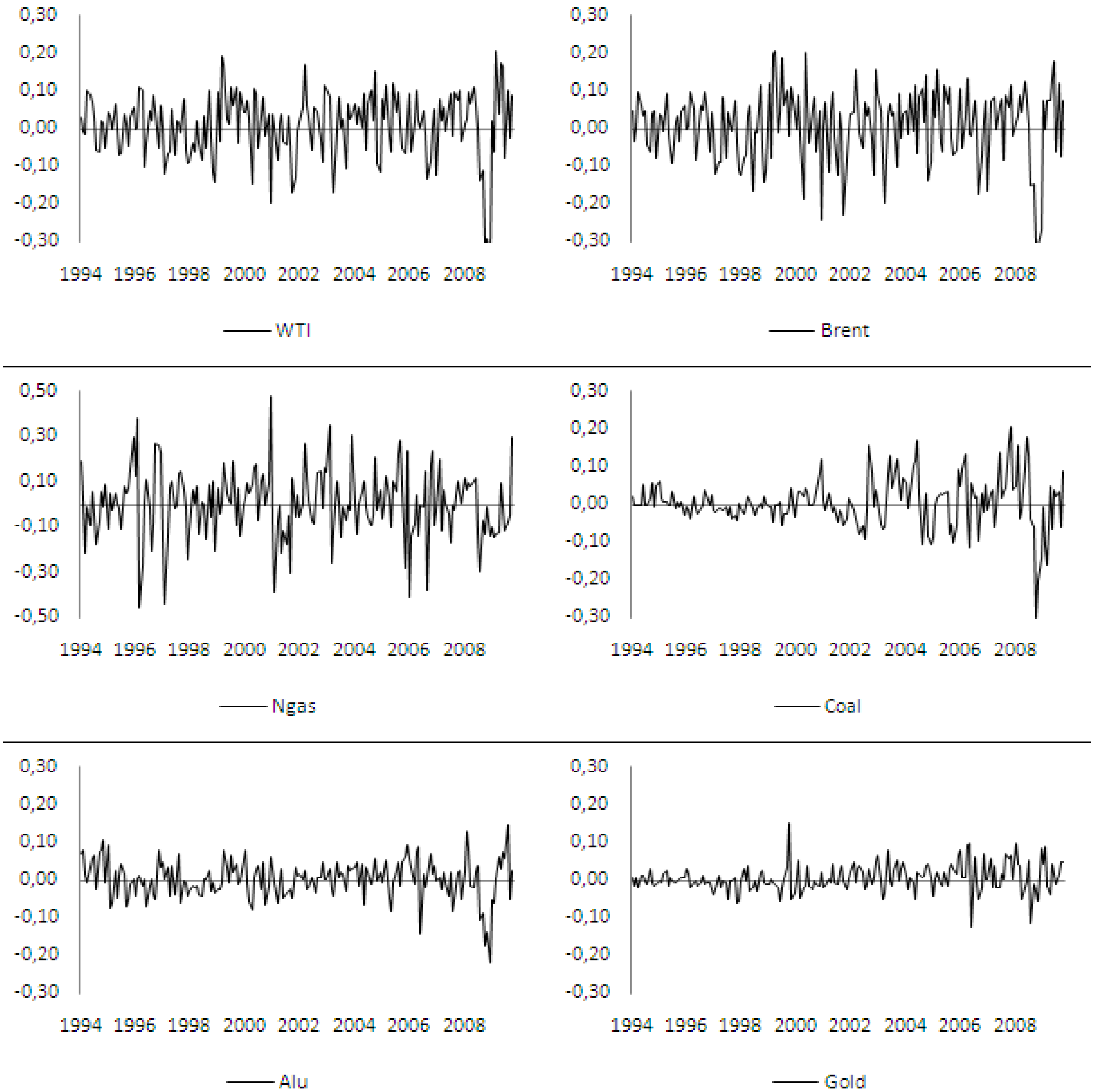


Table 2: Descriptive statistics and normality and stationary test statistics for monthly returns and absolute returns

Time period 1 (1994-2002)	*WTI*	*Brent*	*Ngas*	*Coal*	*Alu*	*Cu*	*Lead*	*Ni*	*Zi*	*Tin*	*Silver*	*Gold*	*Soyb*
Mean	0.00660	0.00681	0.00764	0.00024	0.00211	-0.00072	-0.00036	0.00315	-0.00186	-0.00111	-0.00060	-0.00125	-0.00190
Median	0.01694	0.01294	0.01122	-0.00138	-0.00031	-0.00314	-0.00413	-0.00612	-0.00668	-0.00033	-0.00281	-0.00422	-0.00486
Standard Deviation	0.07342	0.08660	0.15225	0.03555	0.04177	0.05129	0.04601	0.06723	0.04808	0.04183	0.04446	0.02747	0.05391
Sample Variance	0.00539	0.00750	0.02318	0.00126	0.00174	0.00263	0.00212	0.00452	0.00231	0.00175	0.00198	0.00075	0.00291
Kurtosis	0.04409	0.38117	1.42106	3.83346	-0.45645	1.92700	-0.07547	-0.47046	5.67465	1.78124	3.07800	8.63498	0.95688
Skewness	-0.18486	-0.28476	-0.28406	1.07312	0.31805	-0.12112	0.08834	0.03116	-1.13394	-0.20702	0.69333	1.63028	-0.63335
Minimum	-0.19620	-0.24287	-0.45696	-0.09101	-0.07899	-0.20138	-0.13949	-0.18585	-0.24843	-0.12365	-0.13021	-0.05996	-0.20621
Maximum	0.19287	0.20565	0.47675	0.15429	0.10848	0.14230	0.11026	0.14984	0.11453	0.11833	0.17300	0.15380	0.09816
ADF	-5.159**	-5.000**	-6.833**	-4.178**	-5.426**	-5.155**	-5.806**	-5.434**	-5.762**	-7.424**	-6.174**	-6.573**	-5.639**
Jarque Berà	0.599	1.848	9.029*	78.579**	2.854	14.577**	0.209	1.160	151.80**	12.924**	45.797**	348.01**	10.334**
	[0.741]	[0.397]	[0.011]	[0.000]	[0.240]	[0.001]	[0.901]	[0.559]	[0.000]	[0.002]	[0.000]	[0.000]	[0.006]
Absolute returns													
Mean	0.05972	0.06894	0.11269	0.02422	0.03327	0.03945	0.03732	0.05589	0.03508	0.02977	0.03140	0.01896	0.04255
Median	0.05110	0.05865	0.08622	0.01479	0.02850	0.03265	0.03635	0.05141	0.02899	0.02254	0.02345	0.01363	0.03619
Count	108	108	108	108	108	108	108	108	108	108	108	108	108

Time period 2(2003-2009)	*WTI*	*Brent*	*Ngas*	*Coal*	*Alu*	*Cu*	*Lead*	*Ni*	*Zi*	*Tin*	*Silver*	*Gold*	*Soyb*
Mean	0.01146	0.01149	-0.00205	0.01070	0.00380	0.01672	0.01975	0.01153	0.01164	0.01542	0.01598	0.01385	0.00718
Median	0.02209	0.03468	-0.00675	0.02296	0.01843	0.02457	0.03114	0.03301	0.01740	0.01306	0.03349	0.01113	0.01053
Standard Deviation	0.09992	0.10278	0.14622	0.08923	0.06114	0.09127	0.10208	0.11183	0.08383	0.07241	0.07982	0.04354	0.08530
Sample Variance	0.00999	0.01056	0.02138	0.00796	0.00374	0.00833	0.01042	0.01251	0.00703	0.00524	0.00637	0.00190	0.00728
Kurtosis	2.50899	1.38749	0.51192	1.06272	2.25562	3.92700	1.19523	0.83960	1.39605	1.73327	1.28368	0.76357	2.24751
Skewness	-1.25251	-1.16375	-0.07593	-0.49330	-1.01346	-1.07715	-0.94969	-0.60374	-0.53180	-0.71863	-0.82098	-0.44744	-0.86829
Minimum	-0.33888	-0.31136	-0.40700	-0.30196	-0.21743	-0.35014	-0.29332	-0.38240	-0.28730	-0.24331	-0.22205	-0.12224	-0.32469
Maximum	0.20603	0.18058	0.34987	0.20484	0.14786	0.23077	0.23985	0.24763	0.24399	0.16155	0.19558	0.09608	0.16772
ADF	-4.454**	-4.548**	-5.458**	-3.921**	-3.532**	-4.159**	-4.336**	-4.238**	-3.799**	-3.694**	-4.375**	-4.106**	-4.910**
Jarque Berà	39.336**	22.607**	0.610	6.691*	29.201**	62.743**	16.119**	6.701*	9.717**	15.702**	14.11**	4.402	25.112**
	[0.000]	[0.000]	[0.737]	[0.035]	[0.000]	[0.000]	[0.000]	[0.035]	[0.008]	[0.000]	[0.001]	[0.111]	[0.000]
Absolute returns													
Mean	0.07601	0.08247	0.11113	0.07047	0.04549	0.06515	0.07841	0.09098	0.06514	0.05503	0.06413	0.03521	0.06374
Median	0.06471	0.07418	0.09817	0.05501	0.03233	0.04418	0.05975	0.07985	0.06051	0.04448	0.05021	0.02871	0.04752
Count	82	82	82	82	82	82	82	82	82	82	82	82	82

* significant at the 5% level, ** significant at the 1% level
Critical values for the ADF test is -1.941 (5%) and -2.566 (1%)

3.2 Trading activity

We use open interest and the speculative share of the trading positions as a measure of trading activity. Open interest is the total number of outstanding contracts that are held by market participants at the end of each day. The reason for using open interest in preference for trading volume is that, while volume measures the pressure or intensity behind a price trend, open interest measure the flow of new money into the futures market. We will use CFTC data examine some selected commodities at NYMEX: WTI, natural gas, copper, silver, gold and soybeans[6], and compare these with the trading activity at the ICE (WTI and Brent).

3.2.1 NYMEX commodities

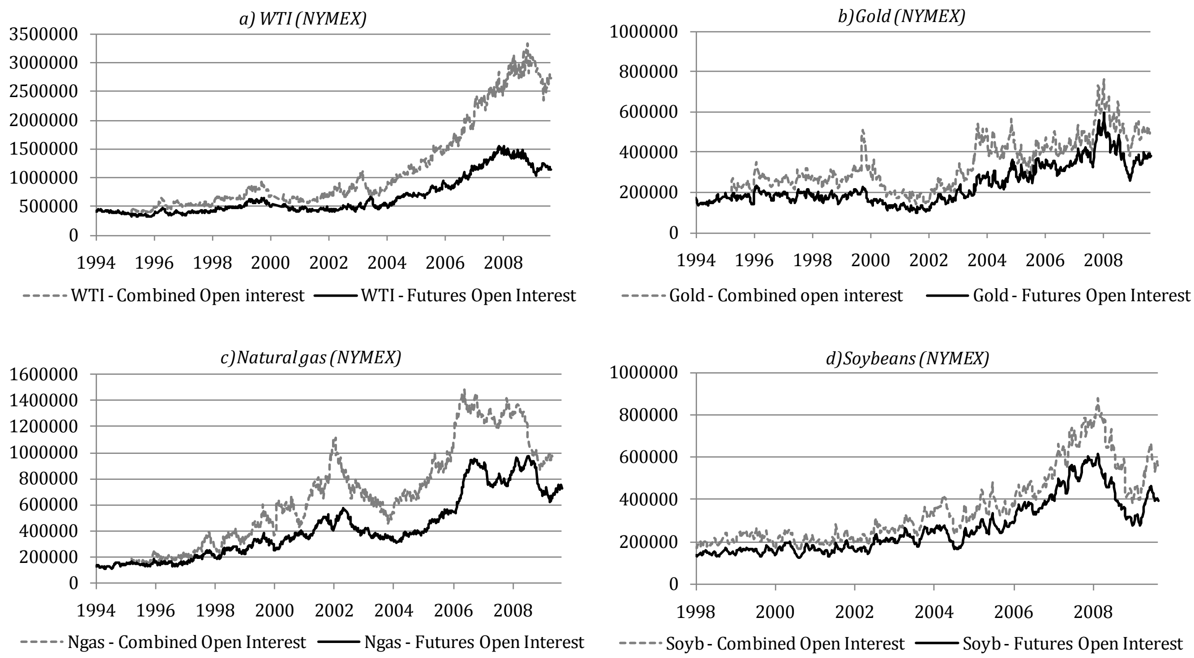
The CFTC publishes a weekly Commitment of Traders (COT) report, which contains a summary of trader´s position in U.S futures markets as of the close of the business on every Tuesday, based on The Large Trader Reporting System (LTRS). The report provides aggregated data on long and short positions for total open interest in the futures markets, and in the combined option-and-futures market. For the latter one, option open interest and traders' option positions are computed on a futures-equivalent basis using delta factors supplied by the exchanges (CFTC, 2009). Long-call and short-put open interest are converted to long futures open interest, and likewise to short open interest for short-call and long-put. We choose to examine both futures and combined positions, since combined data may be more comprehensive than the futures-only data in providing an indication of the balance of speculative and hedging positions. Additionally, there are significant differences in open interest development across the commodities over the last decade depending on whether one considers combined or futures-only[7] data. We define the difference between combined open interest and futures open interest as futures-equivalent positions. Figure 4 illustrates the total futures open interest and combined open interest for some selected commodities.

The activity in the WTI crude oil contracts has grown markedly in the last decade. The strongest growth is seen after 2003 where the number of contracts tripled in four years. Each contract represents 1000 barrels. If we include the future-equivalents, we see an even stronger growth. There were relatively few future-equivalent options traded prior to 2003, with an average level of 170 000 contracts (about 10 percent of the futures open interest). From 2003 it increased gradually to a record level of about 2 million contracts in October 2008, which was more than futures contracts. The open interest for the other NYMEX commodities have also increased during the same period, especially gold, natural gas and soybeans (Figure 4). However, we observe that the futures-equivalent ratio is substantially larger in the WTI than in the other selected commodities.

[6] Coal and Aluminum are not reported in the COT report, since 20 or more traders do not hold positions above reporting levels.

[7] Futures-only positions will be referred to as futures from this point.

Figure 4: Open Interest futures and combined positions for selected commodities.



The COT-report aggregates the LTRS data into commercial, non-commercial positions and non-reportable positions. All of a traders' reported positions in a commodity are classified as commercial if the trader uses futures contracts in that particular commodity for hedging purposes. Speculative positions are referred to as non-commercial positions in the report. The open interests which cannot be classified into either non-commercial or commercial positions, since traders are unknown, are referred to as non-reportable positions. A weakness with the COT-report may be that swap-dealers, who often merely stand as an intermediary to a speculator, are classified as commercials in the report (Parsons, 2009). For analysis purposes swap-dealers should therefore be classified separately, since they are not physical hedgers. There are other weaknesses in the aggregated COT-report, but for the remainder of this paper we will use the definitions given above.

The breakdown for futures and combined positions are almost identical, therefore we illustrate futures positions. Figure 5 breaks down the total open interest into type of traders, presented in long futures positions[8]. The spread positions express the extent to which each non-commercial trader holds equal long and short futures positions. The open interest for commercial traders in WTI crude oil futures contracts have approximately doubled in absolute size during the time period from 1994 to 2009. The noncommercial traders have during the same period increased their market presence about 20-fold, largely due to spread trading. This is though not a unique trend for WTI. We observe the same pattern in all the other commodities examined. The breakdown for futures and combined positions are almost identical, therefore we illustrates only one of them here.

[8] Non-reportable positions omitted.

Figure 5: Breakdown of futures open interest for selected commodities.

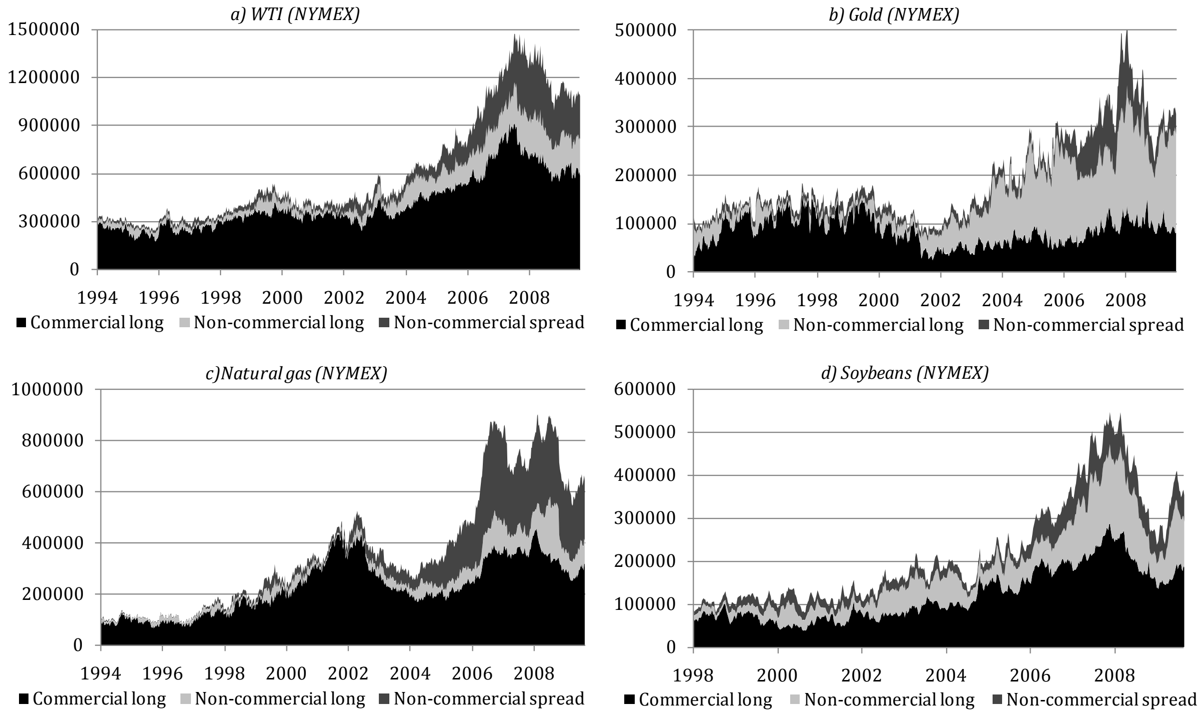
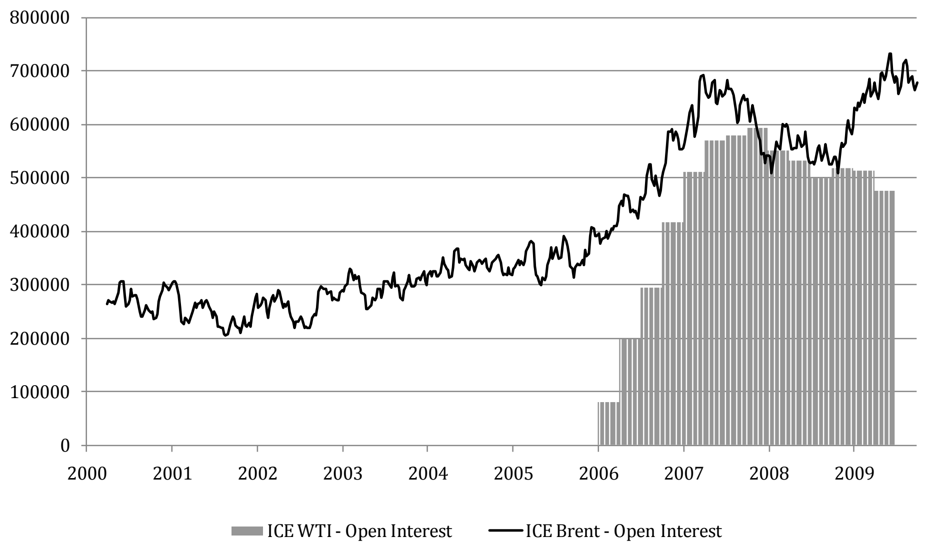


Figure 6: Open Interest for ICE Brent and ICE WTI Futures



3.2.2 ICE commodities

The other major exchange for oil futures is the London based ICE[9]. Open interest data for Brent crude oil are available from 2000, and presented in Figure 6[10]. ICE Brent Crude futures more

[9] Natural gas contracts are also traded on the ICE exchange. Unfortunately we were not able to get sufficient data to analyze the trading activity for this commodity on the ICE.

[10] Daily data for ICE Brent collected from Reuters EcoWin database, while ICE WTI data are collected from ICE annual- and quarterly reports.

than doubled from a level of about 300 000 contracts in 2003 to almost 700 000 contracts in April 2007. ICE WTI futures which were introduced in January 2006, grow rapidly to 600 000 contracts in October 2007, which correspond to about 40 percent of the total open interest on the NYMEX exchange. Quarterly data for ICE WTI futures are shown in Figure 6.

The ICE does not break down the open interest data into commercial and non-commercial positions, but we will like to stress the effect these positions may have on the overall crude oil price volatility.

4 Analysis

4.1 Dispersion and differences in returns across commodities

To test our hypothesis (H1) of whether crude oil prices are more volatile than other commodities we first employ two methods for testing the equality of variances across the samples. Brown and Forsythe (1974) extended Levene's test (Levene, 1960) and the Fligner-Killeen tests are most robust against departures from normality (Conover, Johnson, & Johnson, 1981), and these are found most applicable for the data sets studied. The results are presented in Table 3. Similar results were found testing against Brent, and hence we will not present these here.

Columns (1) and (2) display test statistics for the dispersion between returns in the commodities compared to crude oil (WTI). The statistical results suggest that in the full and first time period the price changes for all commodities are significantly different from that in crude oil, except for nickel. Results for the second time period (2003-2009) demonstrate a different picture. Most commodities, except for natural gas, aluminum and gold (results are ambiguous for tin), are not significantly different from the price changes seen in crude oil. The results from time period one are similar to those obtained by Plourde & Watkins (1998), with the exception of lead and zinc.

The results have led to a suspicion that the commodities are moving more closely together with each other in the second time period than what is observed in the former. This belief is confirmed by investing the correlation between the commodities in the two periods. Table 4 shows that the correlation between returns in crude oil and the other commodities have increased considerably from the first period to the latter. In fact the correlation has increased between all commodities, with some exceptions for natural gas. This might explain the failure to reject the null-hypothesis of equal variances in the second time period.

The dispersion of returns and equality of variances is only one aspect of the of price volatility. In addition we want to investigate the size and significance of the difference between returns in crude oil and other commodities. To avoid problems with large negative and positive returns balancing each other out we focus on absolute rate of returns. The means and medians displayed in Table 2 show that crude oil exceeds most commodities in both time periods.

Table 3: Test Statistics and significance levels for analysis of equality of variances across commodities

Full time period

	Monthly return dispersions				Absolute monthly returns	
WTI	Levene's test		Fligner-Killeen		MWW	
	Test Statistics (1)		Chi-squared (2)		Location diff (3)	
Brent	1.68		1.64		-0.00692	
Natural Gas	33.19	**	31.01	**	-0.03045	
Coal	14.06	**	15.81	**	0.02111	**
Aluminum	29.15	**	29.81	**	0.02229	**
Copper	6.96	**	9.23	**	0.01582	**
Lead	2.90		3.90	*	0.01245	**
Nickel	1.36		1.96		-0.00422	
Zinc	9.49	**	10.76	**	0.01637	**
Tin	21.92	**	22.6	**	0.02270	**
Silver	13.05	**	13.38	**	0.01851	**
Gold	71.1	**	68.83	**	0.03357	**
Soyb	5.68	**	5.75	**	0.01272	**

Time period 1

	Monthly return dispersions				Absolute monthly returns	
WTI	Levene's test		Fligner-Killeen		MWW	
	Test Statistics (1)		Chi-squared (2)		Location diff (3)	
Brent	2.24		2.22		-0.00574	
Natural Gas	24.81	**	21.97	**	-0.03291	
Coal	46.20	**	41.37	**	0.03090	**
Aluminum	25.31	**	22.82	**	0.02154	**
Copper	12.41	**	12.14	**	0.01726	**
Lead	17.35	**	16.14	**	0.01735	**
Nickel	0.22		0.18		0.00146	
Zinc	19.04	**	18.77	**	0.02135	**
Tin	30.35	**	27.14	**	0.02640	**
Silver	26.11	**	26.07	**	0.02528	**
Gold	69.41	**	59.37	**	0.03404	**
Soyb	8.71	**	8.40	**	0.01400	**

Time period 2

	Monthly return dispersions				Absolute monthly returns	
WTI	Levene's test		Fligner-Killeen		MWW	
	Test Statistics (1)		Chi-squared (2)		Location diff (3)	
Brent	0.22		0.21		-0.00732	
Natural Gas	8.97	**	8.89	**	-0.02600	
Coal	0.25		0.10		0.00280	
Aluminum	9.89	**	10.94	**	0.02482	**
Copper	1.30		1.92		0.01214	
Lead	0.05		0.01		-0.00028	
Nickel	2.57		3.66		-0.01435	
Zinc	0.80		0.66		0.00758	
Tin	4.08	*	3.69		0.01631	**
Silver	1.44		1.52		0.00880	
Gold	21.41	**	21.91	**	0.03263	**
Soyb	0.79		0.65		0.01028	

(3) is the point estimate for the difference between WTI and the corresponding commodity
*Significant at the 5% significance level
**Significant at the 1% significance level

To test the significance and size of these differences we apply the non-parametric Mann-Whitney-Wilcoxon 2-sample rank test. The null-hypothesis is that the sample median in crude oil (WTI) is equal to the other commodities studied in this paper, and the alternative hypothesis is that it is greater. Point estimates of the difference between crude oil (WTI) and the other commodities are reported column (3) in Table 3 together with significance levels.

In the first time period we reject the null-hypothesis and conclude that the absolute rates of return seen in crude oil is significantly higher than most commodities, except natural Gas and Nickel. In fact, for natural gas the absolute rate of return is significantly higher than for crude oil. In the second time period the volatility seen in crude oil is only significantly higher than aluminum, tin and gold. Point estimates for lead and nickel have also turned negative, indicating that price changes might actually be larger in these commodities, although these answers are not significant at a significance level of 5 percent or lower.

For the whole sample period *we conclude (H1) that crude oil is in fact more volatile than nine out of the 11 commodities studied*. However, the results are ambiguous when we look at the time periods separately. Table 3 shows that both WTI and Brent crude do not exhibit equal variances to the other commodities between 1994 and 2002. The test-statistics for the first time period are very similar to those for the full time period, and the price movements seen in this period appear to be the dominant factor that crude oil is found to be more volatile than other commodities. The absolute price changes observed in crude oil are significantly higher than that seen in nine out of the 11 commodities studied. *(H1) However, in the time period from 2003 to 2009 the crude oil price changes are not significantly different from the price changes seen in other commodities.* The commodity prices are moving more closely together and seem to exhibit more similar price patterns. Absolute price changes are only proven to be higher for three out of the 11 commodities and three commodities show signs of greater volatility than the crude oils.

It is noticeable that the differences in price volatility are most distinct between crude oil and gold. Gold prices are set in highly competitive markets, and display the lowest volatility among all commodities. This can be explained by investing Table 1 and note that the market conditions and implication for gold are quite different from that perceived in the crude oil market. Unambiguous differences are also seen between crude oil and natural gas and aluminum. The low storability of natural gas makes it harder to dampen fluctuations in supply and demand and this may cause large price movements. There is no clear explanation why aluminum price volatility is significantly lower, but prices have not been set on competitive markets in the same extent as other commodities, and production is highly dependent on electricity.

Table 4: Change in correlation coefficients between the time periods

	Period 1	*Period 2*	*Difference Period 2 - Period 1*
WTI	1.0000	1.0000	0.0000
Brent	0.9351	0.9548	0.0197
Natural Gas	0.1369	0.3385	0.2016
Coal	-0.0383	0.4187	0.4570
Aluminum	0.2379	0.5647	0.3268
Copper	0.1726	0.6188	0.4462
Lead	0.0374	0.3635	0.3261
Nickel	0.2150	0.3570	0.1420
Zinc	0.0782	0.3592	0.2810
Tin	0.0457	0.5312	0.4855
Silver	-0.0013	0.3039	0.3052
Gold	0.0737	0.2168	0.1431
Soyb	0.0896	0.1844	0.0947

Correlation between WTI and the other commodities

4.2 Dispersion and difference in returns across time periods

The same tests as above are used to analyze the significance of the dispersion of price changes in crude oil and the other commodities across the two time periods. Results are displayed in Table 5. For both crude oils the price variances were not found to be significantly different from one period to the other. The same results were obtained for natural gas and aluminum, but for all other commodities we conclude that the variances are not equal when being compared across the time periods.

Table 5: Test statistics and significance levels for analysis of equality of variance in each commodity across time periods

	Monthly return dispersions				Absolute monthly returns	
	Levene's test		Fligner-Killeen		MWW	
	Test Statistics (1)		Chi-squared (2)		Location diff (3)	
WTI	2.69		1.58		0.01032	
Brent	0.95		0.72		0.01224	*
Natural Gas	0.01		0.00		0.00126	
Coal	44.49	**	36.17	**	0.03431	**
Aluminum	3.70		1.75		0.00672	*
Copper	7.21	**	4.11	*	0.01133	**
Lead	25.76	**	20.76	**	0.02588	**
Nickel	18.17	**	16.19	**	0.02750	**
Zinc	19.80	**	19.76	**	0.02445	**
Tin	16.72	**	15.24	**	0.01830	**
Silver	21.34	**	22.07	**	0.02650	**
Gold	19.93	**	22.57	**	0.01224	**
Soyb	10.02	**	9.00	**	0.01190	*

(3) is the point estimate for the difference between absolute returns in period 2 and 1.
*Significant at the 5% significance level
**Significant at the 1% significance level

Differences in absolute returns are examined in the same manner as above using the Mann-Whitney test. Point estimates in column (3) in Table 5 for crude oils indicate that the absolute returns have increased by one percentage point in the second time period. The result is only significantly different from zero at the 5 percent level for Brent crude. The other commodities also exhibit an increase in the absolute price changes. The point estimates are larger and significantly different from zero for all the other commodities except for natural gas. So, when comparing the change in volatility to the other commodities, crude oil has not shown a greater increase. Eight out of the 11 commodities studied have shown significant increases in absolute rates of return that are higher than that seen in both Brent and WTI. This leads to the conclusion for our hypothesis (*H2*) that *crude oil price volatility has not increased significantly after 2003, and most other commodities display a greater and more significant increase*.

Running the same tests using daily rates of return show the same trends as in the results shown above. Results are available upon request.

4.3 Trading activity

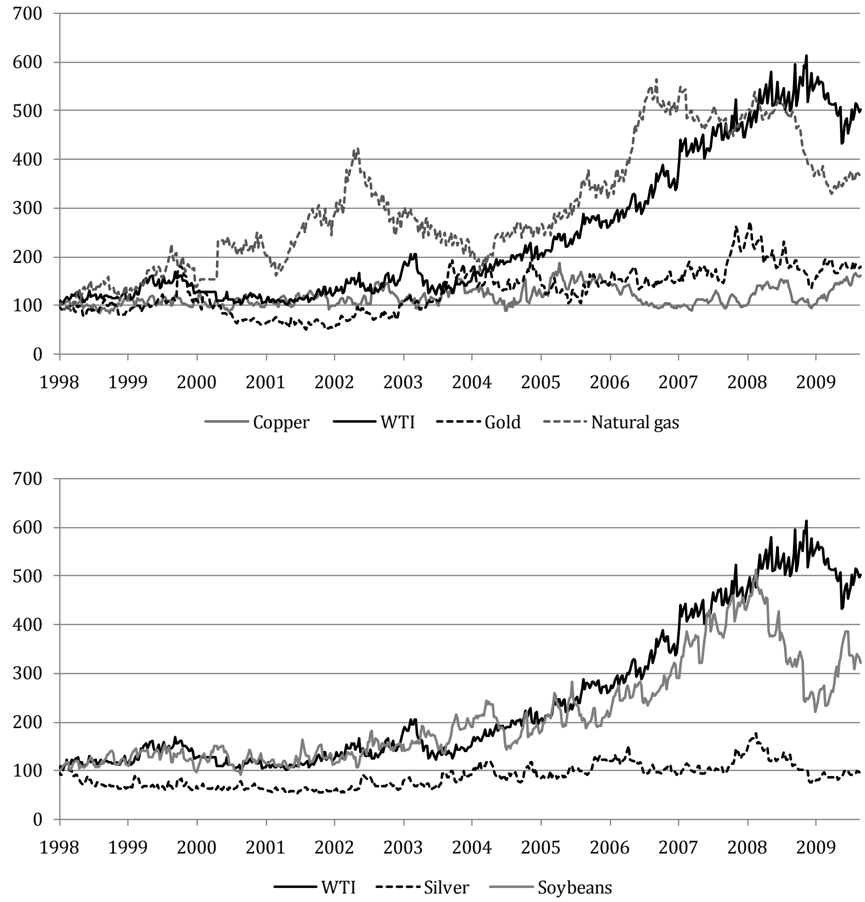
4.3.1 Open interest

To compare the development of trading activity in the different commodities, we have rebased the open interest data to a level of 100 starting in January 1998[11]. Figure 7 illustrates growth in open interest in WTI against the other NYMEX-commodities. The time series are divided into two graphs to increase the readability. We observe that there seems to be a shift of regime in WTI and soybeans market around year 2003, from a relatively stable level to strong growth and increasing week-to-week variation in the number of open contracts. We do not observe the same growth in silver, gold and copper market, although the mean level in gold contracts has doubled from the 1994-2003 to the 2003-2009 period.

Open interest in natural gas, spiked in 2002 and 2006, and seems to behave quite different from the other commodities. The reason for this could be the difference in commodity characteristics, summarized in Table 1. Further, the increased variation in open interest, which seems to be a common pattern for all commodities, may indicate more speculation in the commodity market as investors move in and out of the market more frequently than before.

[11] Soybeans data only available from January 1998.

Figure 7: Rebased open interest



The increase in crude oil open interest has been significant in the 2003-2009 period, especially if we include the option market. In addition to the NYMEX-traded WTI contracts, we have ICE-traded WTI contracts which were introduced in 2006, and as we observed in Figure 6 increased rapidly. The aggregated NYMEX and ICE futures positions in WTI increased 400 percent between 2003 and 2007. Including the future-equivalents the growth is even stronger. Strong growth in open interest is also prominent in natural gas-, gold- and soybeans-contracts, all with an increase on about 300 percent from 2003 to top-level at the end of 2007. Looking at the change in mean level of open interest from period 1 to period 2, NYMEX WTI futures increased 210 percent. This is not clearly above the other commodities. Natural gas, gold- and soybeans all increased by about the same percentage. Including ICE WTI futures, though, makes the percentage increase for WTI futures contracts slightly higher than the other commodities. Finally, if we include the future-equivalents the increase in open interest for crude oil is significantly higher than in the other commodities. Hence, our hypothesis (*H3) that crude oil open interest has increased more than the other commodities* seems to be correct.

4.3.2 Speculative positions

To investigate the proportion of speculators in the commodities, we have computed the non-commercial ratio of long and short positions, using the following definitions:

$$NCLR = \frac{NCL + NCSP}{OI - NRLP} \qquad NCSR = \frac{NCS + NCSP}{OI - NRSP}$$

Where:

NCLR = Non-commercial long ratio
NCSR = Non-commercial short ratio
NCL = Non-commercial long positions
NCS = Non-commercial short positions
NCSP = Non-commercial spread positions
NRLP = Non-reportable long positions
NRSP = Non-reportable short positions
OI = Total open interest

Figure 8: Non-commercial ratio for selected commodities futures

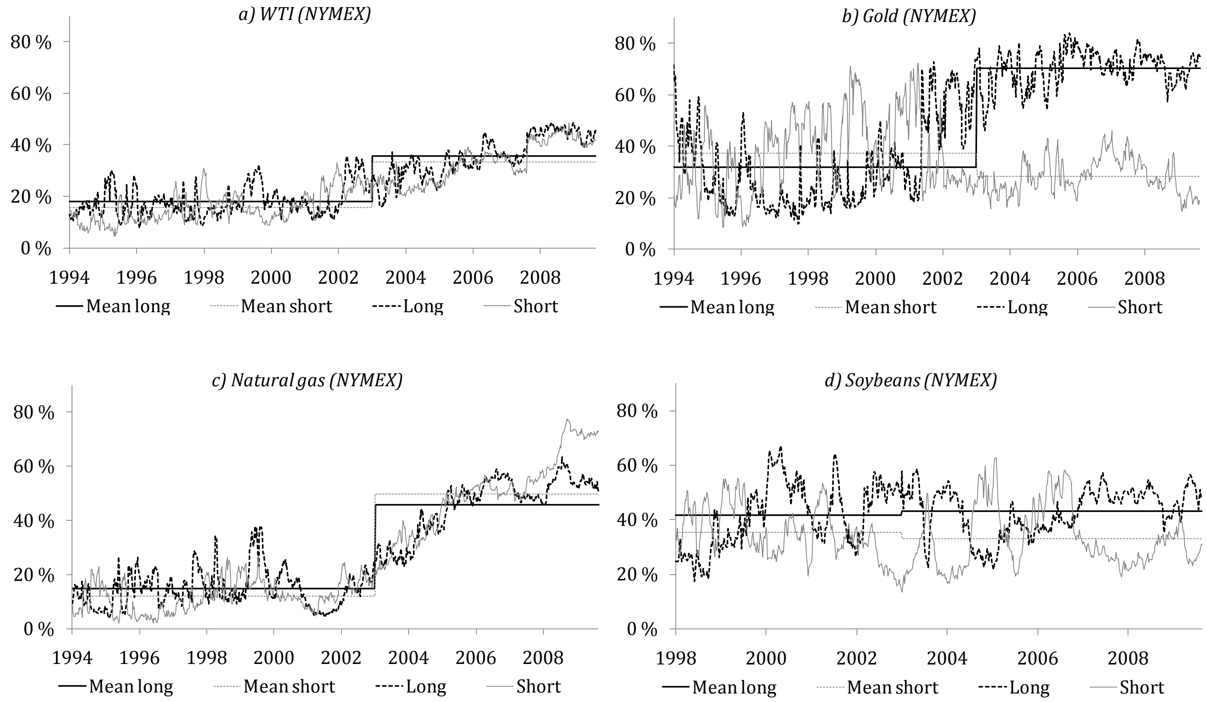


Figure 8 illustrates the non-commercial ratio for long and short futures positions for selected NYMEX-traded commodities. The non-commercial ratio in WTI has increased during the time period we examine, from an average level of 17 percent in period 1994-2002 to 34 percent in period 2003-2009. The average level in the last period is in the lower range of the six commodities we have investigated. All the other commodities considered, had average level above 40 percent in this period. Not surprisingly, the non-commercial ratio was largest in the precious metals, gold and silver, with an average of about 70 percent. Precious metals have long traditions for trading and are almost considered as currencies (especially gold). In addition, there is little new production, and hence less need for physical hedging (Table 1).

As presented in Table 6 the average non-commercial ratio for long WTI contracts increased 18 percentage-points from period 1 to 2. We observe a much larger increase in natural gas and gold. Further, we see from Table 7 that the non-commercial short ratio has increased alongside the non-commercial long ratio for WTI, and both the ratios are about the same level[12]. In contrast, we observe that the percentage non-commercials in short positions are substantially lower than percentage non-commercial in long positions in silver, gold and partially soybeans. In general, the average level of percentage short positions was quite similar in all the commodities in the second period.

Table 6: Non-commercial long ratio, futures

Time peiod 1(1994-2002)	*WTI*	*Ngas*	*Cu*	*Gold*	*Silver*	*Soyb*
Mean	0,18	0,15	0,36	0,32	0,65	0,42
Minimum	0,08	0,04	0,14	0,10	0,31	0,18
Maximum	0,36	0,38	0,75	0,74	0,94	0,67

Time period 2 (2003-2009)	*WTI*	*Ngas*	*Cu*	*Gold*	*Silver*	*Soyb*
Mean	0,36	0,46	0,41	0,70	0,70	0,43
Minimum	0,16	0,23	0,17	0,46	0,47	0,22
Maximum	0,49	0,64	0,74	0,84	0,90	0,59

Difference (percentage points)	*WTI*	*Ngas*	*Cu*	*Gold*	*Silver*	*Soyb*
Mean	0,18	0,31	0,05	0,38	0,05	0,02

Summarized, *we cannot conclude that the share of non-commercial traders as part of total open interest has increased more in WTI than for other commodities (H4)*. Two of the other commodities have increased considerably more. The mean ratio of speculative positions in the crude oil market has increased significantly from the first period to second, but the ratio is still in the lower range of the commodities investigated. We also note that the observed maximum ratio in crude oil (long) is clearly lower than in the other commodities in the second time period. The combined positions for the investigated commodities show more or less the same ratios, and are therefore not presented here.

Table 7: Non-commercial short ratio, futures

Time peiod 1(1994-2002)	*WTI*	*Ngas*	*Cu*	*Gold*	*Silver*	*Soyb*
Mean	0,16	0,12	0,23	0,37	0,26	0,35
Minimum	0,04	0,02	0,05	0,08	0,07	0,14
Maximum	0,33	0,27	0,58	0,72	0,57	0,55

Time period 2 (2003-2009)	*WTI*	*Ngas*	*Cu*	*Gold*	*Silver*	*Soyb*
Mean	0,33	0,50	0,37	0,28	0,23	0,33
Minimum	0,20	0,20	0,09	0,15	0,06	0,14
Maximum	0,49	0,78	0,61	0,46	0,41	0,63

Difference (percentage points)	*WTI*	*Ngas*	*Cu*	*Gold*	*Silver*	*Soyb*
Mean	0,18	0,38	0,14	-0,09	-0,03	-0,02

[12] This contradicts the allegation that non-commercials were long-only in WTI futures during the period prior to the price spike in 2008.

4.3.3 The influence of ICE WTI contracts and unregulated OTC trading

ICE WTI futures contracts have become a serious competitor to the traditional NYMEX contracts, with about 40 percent of the trading activity on NYMEX. Since ICE does not break down the traders into commercial and noncommercial traders, it is hard to say how large part of the trading which speculators constitute. However, according to the consensus in the CFTC hearings (2006), there is reason to believe that a large part of the ICE WTI futures trading are done by speculators. By trading WTI futures via the ICE exchange, known as "London loophole", speculators avoid CFTC oversight and hence COT reporting.

Several reports, among them a US Senate staff report (2006), stress the influence the unregulated OTC trading might have on the crude oil volatility. There are, however, very limited data on the magnitude of unregulated trading in the different commodities. Cleared OTC contracts for crude oil are traded both on the NYMEX[13] and the ICE exchange. The Bank of England suggests that up to 90 percent of swaps and option trading in oil is done in the OTC market (Campbell, 2006). The notional value of OTC commodity derivatives contracts outstanding reached about $13,2 trillion in mid-2008, about the 30 times the value in 1998 (BIS, 2009). A report by Bank of International Settlements suggests that the OTC market is particularly important for oil (Domanski & Heath, 2007). Though there are very limited data on the size of the oil OTC market, Campbell (2006) suggest that the OTC oil derivates market is significantly larger than the exchange-traded oil futures market.

To examine the speculative proportions in the OTC-market we collected data from ICE[14] (ICE, 2005-2009). Open interest for cleared ICE OTC contracts for global oil (including WTI and Brent contracts) are still relatively small on the ICE exchange compared to the ICE futures market. The open interest for oil was 98 000 contracts in 2008 (each contract representing 1000 barrels), compared to 3000 contracts in 2003. Table 8 present the average non-commercial ratio for each year from 2003 to 2009[15] for the ICE OTC market[16]. We observe that the non-commercial ratio increased significantly from 2003 to 2007, and is markedly higher than the ratio for the energy futures contracts at the NYMEX-exchange. This indicates that there is a larger share of financial investors in the OTC-market than in the regulated futures market, possibly due to some financial institutions desire to avoid market monitoring. We note that the OTC market seems to have increased significantly in the recent years, and hence may hide large speculative positions which could influence the market volatility. There is however insufficient data to do any further analysis.

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[13] NYMEX ClearPort.
[14] We were not able to get data on OTC-contracts on NYMEX ClearPort.
[15] Q1 data for 2009.
[16] Oil, Natural gas and electricity contracts.

Table 8: Non-commercial ratio ICE OTC

OTC Participants	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Commercial	0,64	0,56	0,49	0,47	0,46	0,47	0,50
Non-commercial[17]	0,36	0,44	0,51	0,53	0,64	0,53	0,50

4.4 The relationship between trading activity and price changes

To analyze the influence open interest and speculative positions have on price changes we use a nested regression model. Log-returns $r(t)^c$ for each commodity c are used as the dependent variable. Three determinants are used to test the relationship:

$dOI(t)^c = change\ in\ open\ interest\ for\ commodity\ c$

$dNCLR(t)^c = change\ in\ noncommercial\ long\ ratio\ for\ commodity\ c$

$dNCLS(t)^c = change\ in\ noncommercial\ short\ ratio\ for\ commodity\ c$

We develop four models for each commodity; three restricted models, and one unrestricted (full) model. The first restricted model, our reference model, is a simple autoregressive model with m lags. The autocorrelation functions for each commodity has been studied to determine the number of lags and we present the significant coefficients where these are obtained.

$$(1)\quad r(t)^c = \alpha_0 + \sum_{i=1}^{m} \alpha_i r(t-i)^c + \varepsilon_t$$

To examine the relationship we compare the reference model with the following two restricted models, incorporating the effect of changes in open interest and ratio of speculative positions respectively:

$$(2)\quad r(t)^c = \alpha_0 + \sum_{i=1}^{m} \alpha_i r(t-i)^c + \beta_1 dOI(t)^c + \varepsilon_t$$

$$(3)\quad r(t)^c = \alpha_0 + \sum_{i=1}^{m} \alpha_i r(t-i)^c + \beta_2 dNCLR(t)^c + \beta_3 dNCSR(t)^c + \varepsilon_t$$

The full model is the unrestricted model including all the independent variables:

$$(4)\quad r(t)^c = \alpha_0 + \sum_{i=1}^{m} \alpha_i r(t-i)^c + \beta_1 dOI(t)^c + \beta_2 dNCLR(t)^c + \beta_3 dNCSR(t)^c + \varepsilon_t$$

Table 9 shows the regression coefficients and their significance level along with the contribution of the explanatory variables added in each model. The relationship between price movements and open interest (2) is strong in crude oil, however the same effect is seen in gold, silver and soybeans as well. Speculative positions (3) demonstrate the strongest relationship with price

[17] ICE report this category as: 1) Banks and financial institutions, and 2) Hedge funds, locals and proprietary trading shops.

changes in all commodities, except for copper and gold. Crude oil price changes are found to be in the top range with respect to its relationship with speculative positions for long and short positions. However, soybeans display a considerably stronger relationship than that observed in crude oil. A consistent observation is that open interest is not as significant as speculative positions in its relationship with price movements. It is worth noting that NCLR have a consistent positive relation and NCSR has a negative relation with price changes in all commodities. This supports our hypothesis that speculative positions do affect price movements; an increase in speculative long positions has a positive effect on price movements and increases in speculative short positions have a negative effect on price movements.

We conclude that *there is a relationship between the change in speculative positions and price changes and likely also volatility* (*H5*). This is not exclusive for crude oil as we observe the same trend in five of the six commodities studied here as well. The relationship is weaker for open interest as the full model (4) is only significantly better than the restricted model (3), without OI, for three out of the six commodities; crude oil, gold and silver.

The residuals in some of the restricted models are not normally distributed and cannot be classified as white noise. If other exogenous variables are added it might cause some of the coefficients to become less significant, especially for restricted model (2).

Table 9: Nested regression models using OI and NCSR/NCLR as dependent variables and the significance of the models[18]

Crude Oil	Reference Model (1)	Restrcited Model (2)	Restrcited Model (3)	Full model (4)
Constant	0.003	0.001	0.002	0.001
Lagged returns				
Lag 1	0.270 **	0.267 **	0.360 **	0.348 **
Total Open interest				
OI		0.606 **		0.362 **
Speculative positions				
NCLR			0.444 **	0.375 **
NCSR			-0.290 **	-0.288 **
R-squared	0.073	0.189	0.354	0.391
F-statistic (1)		26.080 **	78.878 **	94.020 **
F-statistic (2) vs. (4)				59.675 **
F-statistic (3) vs. (4)				10.850 **
No. of obs	185	185	185	185

Natural Gas	Reference Model (1)	Restrcited Model (2)	Restrcited Model (3)	Full model (4)
Constant	0.003	-0.001	0.003	0.001
Lagged returns				
Lag 1	0.105	0.112	0.148	0.148 **
Total Open interest				
OI		0.401 *		0.125
Speculative positions				
NCLR			1.138 **	1.072 **
NCSR			-0.986 **	-0.983 **
R-squared	0.011	0.037	0.187	0.193
F-statistic (1)		4.983 *	39.144 **	40.032 **
F-statistic (2) vs. (4)				34.222 **
F-statistic (3) vs. (4)				1.264
No. of obs	185	185	185	183

Copper	(1)	(2)	(3)	(4)
Constant	0.006	0.005	0.006	0.006
Lagged returns				
Lag 1	0.246 **	0.256 **	0.249 **	0.252 **
Total Open interest				
OI		0.122 *		0.163 *
Speculative positions				
NCLR			0.128	0.037
NCSR			-0.183 *	-0.274 **
R-squared	0.060	0.081	0.128	0.155
F-statistic (1)		4.237 *	14.070 **	20.381 **
F-statistic (2) vs. (4)				15.822 **
F-statistic (3) vs. (4)				5.928 *
No. of obs	185	185	185	185

Silver	(1)	(2)	(3)	(4)
Constant	0.005	0.005	0.005	0.005
Lagged returns				
Lag 1	0.149 *	0.118	0.162 *	0.133 *
Total Open interest				
OI		0.230 **		0.203 **
Speculative positions				
NCLR			0.440 **	0.38597 **
NCSR			-0.116	-0.145 *
R-squared	0.030	0.144	0.335	0.423
F-statistic (1)		24.265 **	83.246 **	122.501 **
F-statistic (2) vs. (4)				86.914 **
F-statistic (3) vs. (4)				27.204 **
No. of obs	185	185	185	185

Gold	(1)	(2)	(3)	(4)
Constant	0.005	0.004	0.004	0.003
Lagged returns				
Lag 1	0.060	0.050	0.090	0.060
Total Open interest				
OI		0.004 **		0.134 **
Speculative positions				
NCLR			0.246 **	0.145 **
NCSR			-0.041	-0.102 **
R-squared	0.010	0.173	0.280	0.374
F-statistic (1)		35.852 **	67.797 **	104.395 **
F-statistic (2) vs. (4)				57.591 **
F-statistic (3) vs. (4)				26.897 **
No. of obs	185	185	185	185

Soybeans	(1)	(2)	(3)	(4)
Constant	0.004	0.003	0.003	0.003
Lagged returns				
Lag 1	0.297 **	0.290 **	0.249 **	0.245 **
Total Open interest				
OI		0.201 **		0.082
Speculative positions				
NCLR			0.457 **	0.402 **
NCSR			-0.540 **	-0.541 **
R-squared	0.090	0.156	0.454	0.464
F-statistic (1)		10.507 *	88.719 **	92.018 **
F-statistic (2) vs. (4)				75.729 **
F-statistic (3) vs. (4)				2.379
No. of obs	137	137	137	137

*Significant at the 5% significance level
**Significant at the 1% significance level

[18] The significance of the nested models are determined by the F-statistic: $F = \frac{(R_F^2 - R_R^2)/(k_F - k_R)}{(1 - R_F^2)/(N - k_F - 1)}$, where R_F^2 and R_R^2 is the coefficient of determination and k_F and k_R of the full/unrestricted models and restricted models respectively, and *N* is the number of observations (Allen, 1997).

5 Conclusions

We present a comparison of the crude oil market characteristics and price volatility with eleven other commodities over the 1994-2009 period. The time period was split in our analysis to study the effect of the CFMA of 2000, which deregulated the futures markets and led to increased trading volumes. We have studied open interest, speculative positions and price volatility across the commodities and across the two time periods.

Most price series displayed departures from normality and we have used three non-parametric methods to study two dimensions of price volatility; the dispersion of variances of price changes and the difference in absolute rates of return. We conclude that crude oil is in the upper range of all measures of price volatility in the time period from 1994 to 2002. The results are, however, different in the time period from 2003 to 2009 where crude oil price volatility is found to be similar to most commodities studied. Price volatility is found to be significantly higher in the second time period for most commodities, but this is not observed in crude oil. We conclude that the other commodities now display more similar price volatility as crude oil and that price movements have become more correlated across all commodities over the two time periods. Differences in commodity characteristics and price formation might explain the dispersion of price movements, especially in the first time period. Over the years all commodities more competitive pricing mechanisms and the increased interest for commodities among financial investors might lead commodities to behave more like other financial assets.

The open interest for crude oil futures has increased significantly since 2003. The growth is especially strong in the option market, a market which was virtually absent in the first period examined. A strong growth is also seen in the other commodities, but none of the other commodities can point to a similar growth in the combined market. The introduction of ICE Brent and WTI futures contracts made a significant contribution to the open interest and has lead to the notion that crude oil has probably increased more than the other commodities investigated. This could possibly be explained by the index funds' increasing entry in the commodity market, and especially the crude oil market.

Despite this trend we find the non-commercial ratio for crude oil in the lower range of the commodities investigated, and significantly lower than in the precious metals. The speculative long ratio increased from an average of 18 percent to 36 percent in the time period, but in two of the six commodities investigated the ratio increased significantly more. The strong focus on crude oil price movements has also led to more extensive hedging among companies exposed to oil, and commercial positions have also grown significantly. The period after the CFMA does not exhibit a significant increase in crude oil price volatility, but the opposite conclusion is reached for trading activity. Regulators have given excessive volatility and speculation in the crude oil market additional attention recently. Our results show that if stricter regulations and position limits are considered on this basis alone, restrictions should probably be considered for a broader range of commodities as well.

This paper has not focused on whether price volatility is caused by trading activity, or if the relationship is the other way around. Granger causality tests can be used to test the cause and effects of the relationship.

We analyzed the relationship between open interest and speculative positions with price movements using nested regression models for the six of the commodities we obtained data for. We show that there is a significant relationship between price movements and speculative positions in crude oil. The relationship is also observed in other commodities and is, hence, not exclusive for the crude oil market. Crude oil prices also seem to exhibit a significant relationship with open interest. This is also seen in gold and silver where trading activity has been high for a long time and the proportion of speculative traders is high. The similarities again suggest that crude oil is showing more similarities with other financial assets.

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