The Financialization and Maturation of Commodities Markets

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Abstract

In this paper I examine the financialization of commodities since the financial crisis by looking at oil price correlation for a set of 24 non-energy commodities. I focus on the impact of index investing by classifying all commodities as either on-index or off-index, depending on their inclusion in a large commodity index. I find that oil price correlation is higher for on-index commodities for 2008 and 2009 but not for 2010 to 2013. This shift coincides perfectly with the relative equalization of trading volumes for on-index and off-index commodities. I argue that this signals the maturation of commodities markets and a widening of commodity investing.

Keywords: Financialization, Commodity Investing, Index Investing
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1 Introduction

Approximately ten years ago, institutional investors discovered commodities as an asset class. Academic articles in the early 2000s showed that investments in commodity futures had equal or higher Sharpe ratios[1] than equity or fixed income investments. Moreover, commodities had low or even negative correlations with stocks and bonds and provided effective insulation against unexpected inflation. Since then, a long-only position in a diversified basket of commodity futures has been a staple of prudent asset management for many institutional investors. Conditions in the commodities markets of the 2000s were very advantageous for such investments, leading to unprecedented growth in commodity index investing. Indices such as the S&P Goldman Sachs Commodity Index (S&P GSCI) and the Dow Jones UBS Commodity Index (DJ-UBSCI) provided just the type of exposure investors were looking for. By rolling a select set of commodity futures contracts on a monthly basis, investors in these indices were able to profit not only from rising commodity prices but also from the so called roll yield resulting from futures prices consistently lower than spot prices. Tang and Xiong (2012) estimate that commodity index investing grew from $15bn in 2003 to $200bn in 2008.

The dramatic growth in commodity index investing is widely regarded to have caused a financialization of commodities markets whereby individual commodity returns started to correlate with otherwise unrelated commodity returns, and with equity and fixed income returns. This has been documented in several studies such as Silvennoinen and Thorp (2013), and Basak and Pavlova (2013) but perhaps most notably by Tang and Xiong (2012) who find that oil price correlation for non-energy commodities after 2004 is significantly higher for on-index commodities than for off-index commodities.

This paper draws on the findings and methodology of Tang and Xiong (2012) (henceforth Tang and Xiong) and extends their analyses past the financial crisis. Since the onset of the financial crisis and the contemporaneous end of the so called commodity super cycle, commodities markets have gone through structural changes. This paper investigates these changes in the context of financialization and attempts to draw conclusions on the implications for commodity investing.

[1] The Sharpe ratio is a risk-adjusted measure of performance, normally defined as excess return divided by volatility

I focus on the increased correlation between crude oil and a set of non-energy commodities and its development from 2008 to 2013. To isolate the effects of index investing, I categorize all non-energy commodities as either on-index or off-index, depending on their inclusion in either the S&P GSCI or the DJ-UBSCI. I find that the increased oil price correlation for on-index commodities documented by Tang and Xiong disappears after 2009. Furthermore, I show that trading volumes for off-index commodities experienced a downturn relative to on-index commodities during the financialization period between 2004 and 2009 but that levels have equalized since then. That is, there is no longer an observable difference between on-index and off-index commodities in terms of trading volumes or level of financialization as measured by oil price correlation.

These changes strongly suggest that commodity investors are increasingly turning to what would previously have been viewed as outlying or fringe commodities in order to combat negative roll yields and decreasing diversification benefits. I argue that this signifies the maturation of commodities markets in which active asset management plays an increasingly important role. Indeed, I present some evidence of the rise of active commodity investing where funds employ more advanced strategies and invest in a greater range of commodities.

The remainder of the paper is structured as follows: section 2 reviews the most relevant literature on the topic of commodity index investing. Section 3 provides a detailed outline of futures trading, commodity index investing and the mechanics of the roll yield as well as a brief explanation of financialization. Section 4 describes the data and methodology. Section 5 documents the statistical analyses made and provides interpretations of the results. Section 6 discusses the findings in greater detail and section 7 concludes the paper.

2 Literature Review

Commodity investing is a heavily researched topic within the academic finance community. As mentioned in section 1, commodity investing rose to prominence through academic articles exposing the benefits of commodity exposure and the strong returns offered by commodities in the late 1990s and early 2000s. Among the first articles on the subject was a paper written by Ernest M. Ankrim and Chris R. Hensel in 1993 and published in the *Financial Analysts Journal.* Despite presenting a strong case for commodity investing, Ankrim and Hensel were unable to spark the commodities boom eventually to take place in the early 2000s, largely because the market for commodity investing was far too small and illiquid.

Instead, it seems that most industry insiders attribute the rise of commodity investing to a widely publicized paper by Gary Gorton and K. Geert Rouwenhorst, first published in 2006. Their paper, titled *Facts and Fantasies about Commodity Futures*, differed from prior research in that they were able to obtain data on a larger number of commodities over a longer time period. Additionally, their paper was very practically oriented and outlined in a very straight-forward fashion the exact strategy for investing into commodity futures and the returns such a strategy had generated in the past. They also emphasized the importance of the roll yield in generating said returns and showed that the futures position vastly outperformed the spot position because of the roll yield. Like most preceding articles on the subject, they also showed the negative correlations between commodity futures, and stocks and bonds as well as the effectiveness of commodity futures for inflation hedging.[2]

The first prominent study on the financialization of commodities was written in 2008 by Bahattin Bykahin, Michael S. Haigh and Michael A. Robe (published in 2010). They examined the relation between returns on commodity indices and U.S. equity indices but found no significant increase in correlation in the 15 years leading up to 2008. Silvennoinen and Thorp (2013) examine the correlation

[2]Some argue that the success of Gortons and Rouwenhorsts paper was facilitated by significant promotion by AIG which had commissioned the paper and for which Gorton and Rouwenhorst were both working as consultants. AIG would certainly have been interested in promoting commodity investing as it was a major stakeholder in the second largest commodity index at the time, Dow Jones-AIG Commodity Index, today known as Dow Jones-UBS Commodity Index or simply DJ-UBSCI. UBS purchased AIGs stake in the DJ-AIGCI for $150 million in May of 2009 following the restructuring of AIG.

between stocks, bonds and commodity futures and find that correlations did increase during the financial crisis but not before the crisis. Contrary to the above mentioned studies, this paper focuses on cross-commodity correlation as evidence of financialization rather than commodity-equity or commodity-fixed income correlation. The benefit of focusing purely on cross-commodity correlation is that evidence of financialization does not rely on reciprocal investments into either equity or fixed income markets. As such, I consider cross-commodity correlation a more direct and accurate indication of financialization of commodities.

The issue of index investing and its impact on commodity prices was first raised by hedge fund manager Michael Masters in his 2008 testimony before the Committee on Homeland Security and Governmental Affairs in the U.S. Senate. Masters argued that the increasing presence of large institutional investors in commodities markets was unequivocally contributing to spiraling food and energy prices. Singleton (2014) presents evidence to support the arguments of Masters (2008) though the former is heavily criticized in a paper by Irwin and Sanders (2012).

Hamilton and Wu (2014) develop a model of futures arbitrage to examine whether notional positions of index investors in agricultural commodities can explain future returns in the same contracts, but find no evidence of this. Basak and Pavlova (2013) examine the effects of financialization by creating a model of index investing. They find that supply and demand shocks to on-index commodities spill over to all other commodities but that the same is not true for off-index commodities. They also find increased correlation between different commodities and between equities and commodities, and that the increase is larger for on-index commodities than for off-index commodities. However, their model is of a more general nature and does not describe the development of financialization before or after the financial crisis.

Tang and Xiong investigate the correlation between crude oil and a set of non-energy commodities. The rationale behind focusing on crude oil correlation is that index investors by definition trade in and out of all on-index commodities at once, thereby implicitly creating a positive correlation between otherwise unrelated commodities. As crude oil is by far the largest and most liquid commodity, it serves as a good benchmark against which to measure cross-commodity correlation. This rationale is consistent with the work by Barberis, Shleifer and Wurgler

(2005) who find that a given stock's inclusion in the S&P 500 index results in significantly higher correlation between the stock and the index.

Importantly, Tang and Xiong distinguish between on-index commodities and off-index commodities and find that after 2004, crude oil correlation is higher for on-index commodities. However, their data does not stretch past the financial crisis and their focus is purely on the pre-crisis period of the 2000s. Moreover, Tang and Xiong do not decompose their correlation coefficients by year but rather examine the period as a whole. This study is a continuation of the work by Tang and Xiong as I investigate the extent of financialization past the financial crisis on a year-by-year basis and attempt to draw conclusions on the changes occurring within commodity investing.

3 Background

3.1 Futures Trading

By most accounts, futures trading started in early 18th century Japan when, after a number of years of poor rice harvests, certain factions with large rice holdings set up an exchange of sorts in order to monetize their holdings. The futures markets of today did not start for another 130 years when, in 1864, the Chicago Board of Trade (CBOT) was founded. The original purpose of the CBOT was to allow farmers to sell their produce for immediate or forward delivery in order to lock in their profits while prices where high, thus avoiding the risk of a price collapse. The agreement to sell produce for forward delivery was known as a futures contract and quickly became a standardized contract with very specific details as to the volume of produce, type of produce and delivery of said produce. It is important to note that entering a futures contract does not imply any transaction before the expiration date of the contract it is merely a binding agreement of the price in a future transaction.

Despite todays futures trading being almost exclusively electronic, most contracts still presume fulfillment by physical delivery of the commodity. In practice however, the majority of futures contracts are liquidated before the actual delivery date and are settled in cash rather than physical product. Futures markets have evolved since the inception of the agriculture-focused CBOT to now include energy, metals, fibers, spices, currencies, interest rates, equity indices and even weather-related products. In 2013, the total number of futures and options contracts traded amounted to 21.6 billion.[3] Futures trading accounted for 56% of the 21.6 billion, or roughly 12.2 billion contracts traded a staggering 387 contracts traded every second of the year. Considering that futures contracts are generally very large in values (several thousand dollars), this truly is a massive sector.[4] CME Group is currently the largest futures and options exchange operator in the world and operates among others the Chicago Mercantile Exchange (CME), the Chicago Board of Trade (CBOT), the New York Mercantile Exchange (NYMEX)

[3]Every year the Futures Industry Association (FIA) gathers futures trading data from 84 exchanges around the world and summarizes it in their annual volume survey. The FIA is the principal trade organization for the worlds futures, options and swaps markets.

[4]The standard contract size is 1,000 barrels for oil (≈\$100,000), 5,000 bushels for soybeans (≈\$70,000) and 40,000 pounds for lean hogs (≈\$50,000).

and the Kansas City Board of Trade (KCBT). IntercontinentalExchange Group is the second largest and operates several futures and options exchanges under the NYSE and ICE brands.

Futures markets are dominated by two types of traders: hedgers and speculators. Hedgers are typically businesses with commodity-based inputs and/or outputs. They use the futures markets to negate the impact of a drop or surge in the price of their input or output. A farmer might sell his entire expected yield at a fixed price before the harvest even begins at which time prices are impacted by supply and demand fundamentals. Similarly, it is common practice within the low-margin airline industry to hedge a portion of expected fuel consumption by purchasing jet fuel futures. Speculators however, have no real operational interest in the futures contracts they buy and sell but rather act as counterparties to hedgers, hoping to profit from the price movement of the underlying commodity. Speculators play a vital role in futures markets by providing liquidity and assuming the risks of hedgers. Although speculators will commonly approach other speculators to hedge risks assumed from hedgers, their role truly is imperative for efficient futures markets. Parallel to futures markets exist so called over-the-counter (OTC) markets. OTC products are generally tailor-made versions of futures contracts or options. If a trader wants to contract beyond the specifications of the standardized futures contract, for instance by deviating from the standard quantity and/or quality of the underlying commodity, she may approach an OTC swap dealer to negotiate more specific terms. An OTC agreement is not restricted to a single commodity but can track several commodities or even mimic the returns of an entire commodity index. Such OTC commodity index swaps have become increasingly common in recent years and are now analogous to investing in the commodity index directly. Because of the greater flexibility, OTC contracts generally come at a significantly higher price than futures, and because OTC products are not traded on exchanges, there is very little public information about the OTC markets. Investors may also purchase exchange-traded funds (ETFs)[5] or exchange-traded notes (ETNs)[6] with particular commodity index linkages in order to gain exposure to commodities markets although OTC swaps seem to be the most common method of exposure. In fact, a Commodity

[5] ETFs are funds with shares traded on an exchange, much like equities, making them easy to invest in.

[6] ETNs are exchange-traded debt securities whose returns are linked to an index of some sort.

Futures Trading Commission (CFTC) report from 2009 estimates that between 2006 and 2009, commodity index investing through OTC swaps was between 3 and 7 times larger than commodity index investing through managed funds, ETFs and ETNs. Whilst it seems that there are many different ways for fund managers to invest into commodities markets, most (if not all) of the alternative methods outlined above are linked to various benchmark commodity indices, thereby accounting for the particular importance and relevance of large commodity indices.

3.2 Commodity Index Investing

The notion that commodity index investing could provide diversification benefits to a portfolio was first presented in 1993 when Ernest M. Ankrim and Chris R. Hensel published an article in the Financial Analysts Journal titled *Commodities in Asset Allocation: A Real-Asset Alternative to Real Estate*. Their article was intended to highlight the potential for commodity index investing in challenging real estate as the dominant real asset in the portfolios of pension funds.

Real assets are assets that draw value from their intrinsic characteristics. Real estate is the most common example of a real asset but commodities, land or even services such as an hour of a lawyers time can be characterized as real assets because their purchasing power is more or less independent of the price level - e.g. if a barrel of oil could always be traded for eighty pounds of lean hogs. Therefore, the nominal prices of real assets tend to increase with inflation. Nominal assets such as bonds are instead decreasing in inflation. In practice, most assets exist in the spectrum in between strictly nominal and strictly real. Stocks and bonds, however, have historically been denoted as nominal assets. Real assets are therefore an important part of any well-diversified portfolio as they protect investors against the negative effects of (unexpected) inflation. However, real estate had not performed well during the 1980s and many investors were looking for an alternative real asset. One of the major issues with real estate was its illiquidity. Investors were willing to accept the level of risk associated with real estate but when returns turned sour they wanted to be able to liquidate their holdings. As history has repeatedly shown, divesting real estate assets after the bursting of a property bubble can be very difficult.

Ankrim and Hensel argued that commodity futures, by virtue of being exchange traded, provided all the liquidity of equities whilst simultaneously retaining the inflation-insulation of real estate assets. A well-diversified investment in commodity futures would therefore be an excellent addition to any portfolio. Indeed, they showed that a small allocation into either the Goldman Sachs Commodity Index (GSCI) or Intermarket Managements Investable Commodity Index (ICI) would provide not only higher risk-adjusted returns than equities or bonds but also negative correlations to either of the two asset classes. Whilst this might have seemed too good to be true, there was one significant drawback - the size of the market.

In 1990, the combined value of all open interest[7] in commodity futures included in the GSCI amounted to just \$35 billion compared to the \$1.1 trillion in actual physical world production of said commodities. Even worse, if one was to maintain the exact weights of the GSCI, the total investment could not exceed \$3.5 billion due to the limited supply of live hogs futures. Barring inclusion of live hogs, the size of the GSCI would cap at \$12 billion instead, owing to the limited supply of wheat futures. Needless to say, the size of futures markets was much too small for an institutional setting. Nevertheless, Ankrim and Hensel's paper raised some very interesting points and concluded that with \$1.1 trillion in physical world production, there was ample room for commodities futures markets to grow in size and they would be proven correct.

Despite the compelling case made by Ankrim and Hensel, commodity index investing did not immediately take off. The following years saw several academic papers confirm the original findings of Ankrim and Hensel including Lummer and Siegel (1993), Kaplan and Lummer (1998), Anson (1998) and Gibson (1999). What many people failed to realize however, was that investors sought not only a real asset with sufficiently high returns and inflation protection, but also some form of dividend yield such as property rents in the case of real estate. Holding physical commodities does not grant an investor any direct yield or income. In fact, holding physical commodities is often associated with significant storage costs. As such, the return of such an investment relies solely on the appreciation or depreciation of the commodity's price. However, commodity indices like the GSCI held commodity futures rather than actual physical goods and could therefore capture the so called roll yield.

[7] Open interest is defined as the total number of active contracts in the market, i.e. the number of contracts that has been bought or sold but not yet settled.

3.3 The Roll Yield

Consider an investor who wants to maintain a continuous long position in a commodity futures contract. Suppose she purchases a futures contract with expiration in January. As the expiration date of the contract approaches, the price of her contract will start to converge with the spot price and she will need to sell her futures contract and purchase another contract with expiration in February. Sometime in early February she would then sell her February contract and purchase a contract with expiration in March, and so on. Thus, our investor trades in a continuous pattern of purchasing the commodity far away from the spot price and selling the commodity close to the spot price. Inevitably, if the spot price is consistently higher than the futures price, this strategy of rolling futures contracts is generating our investor a positive return:

$$Roll\ yield = \Delta P_F - \Delta P_S$$

where ΔP_F denotes the change in the futures price and ΔP_S denotes the change in the spot price of the commodity. This implies that even if spot prices remain unchanged, rolling commodity futures generates a positive return so long as spot prices are consistently higher than futures prices by casual definition known as normal backwardation with the opposite known as contango.

In a strategy presentation to potential investors in June of 2004[8], representatives of the GSCI showed that since inception, NYMEX WTI crude oil futures had been in a state of normal backwardation 66% of the time. They also showed that holding the WTI spot price for one year in 2003 would generate a mediocre 4.2% return compared to the 26.2% return of rolling the WTI front month future. This roll yield combined with a growing world economy and a generally bullish market for commodities in the early 2000s marked the beginning of the so called commodity supercycle.

3.4 The Commodity Supercycle

Tang and Xiong report that the combined value of all commodity index-related investments amounted to no more than $15 billion in 2003. A CFTC staff report from 2008 draws on data from a special call survey of swap dealers and index

[8]The Case for Commodities as an Asset Class, Heather Shemilt, Selen Unsal, GSCI NY

traders to present what was then the first confirmed numbers on the size of index investing.[9] As of June 30, 2008 the combined value of all open interest commodity futures and options in U.S. markets amounted to $945 billion. Circa 17% of this amount, or $161 billion, was related to index investments. Considering also foreign exchanges, such as the London Metal Exchange where most of the industrial metals included in the largest commodity indices are traded, total commodity-related index investing amounted to $200 billion. This represented a growth of more than 1,000% in the five years between 2003 and 2008.

However, it is important to note that these numbers represent nominal values, i.e. they are not adjusted to exclude the effects of price increases in the underlying commodities. The same period also saw substantial growth in commodity prices which undoubtedly skews the numbers. A CFTC report from 2009 looks at the increase in commodity index-related investment for 12 agricultural commodities between 2006 and 2009 in fixed 2006-level prices. It finds that total index investment in these 12 commodities starts at $20 billion in 2006 and peaks at $40 billion in 2008 before gently declining in 2009 as the crisis hit financial markets. The same pattern in nominal prices shows that total index investment in the 12 commodities starts at $20 billion in 2006 and peaks at $70 billion in 2008 before collapsing in 2009. Despite the potential for such biases, there is no doubt that commodity index investment has grown precipitously over the past decade.

3.5 Financialization

The major concern when a market sees explosive growth over several years is often the risk of a speculative bubble. These are characterized by inflated expectations of future growth leading to an excess of buyers in the market, in turn leading to increasing volumes and prices. However, whether the rise in commodity prices over the last decade should be categorized as a bubble is not the focus of this paper. Instead, I am looking at a somewhat related phenomenon known as financialization.

Although there is no agreed upon definition of what financialization exactly means, most academics seem to have similar views as to what it implies. Krippner

[9] This special call was not immediately intended to go out on a regular basis but the importance of the data acquired resulted in the CFTC instituting the call as a reoccurring quarterly event (changed to monthly in 2010). This data is the basis for several analyses made in section 5 and will be referred to as the CFTCs special call.

(2005), defines it as *"a pattern of accumulation in which profit making occurs increasingly through financial channels rather than through trade and commodity production"*. For the purpose of this study, I define financialization as the growing presence of large institutional investors which alters the way in which a market functions by increasingly aligning that market with the global (in some cases regional) financial markets. This often comes in the form of positive correlation with equity and fixed income markets as well as increasing trading volumes as investors funnel large amounts of money into the market. The latter point usually leads to sharply increasing prices which is why financialization can often be related to or mistaken for a speculative bubble.

Mechanically, an investment into a commodity index requires the simultaneous purchase of all the commodities constituting the index being invested in. For example, investing \$100 million into a commodity index might entail buy orders for \$20 million worth of crude oil futures, \$10 million worth of gold futures and \$5 million worth of wheat futures, among others. Sufficiently high volumes will then cause an upward technical pressure on these futures, causing prices to increase in tandem and thereby creating a positive correlation between otherwise unrelated commodities such as crude oil and wheat.

In theory, such a correlation should only be present for on-index commodities, or at least more distinguished than for off-index commodities, which is why I focus on the differences between these two groups. Naturally, this depends upon one's definition of what constitutes an on-index and an off-index commodity. For the purpose of this study, I define on-index commodities as those included in either the S&P GSCI or the DJ-UBSCI, the two leading benchmark commodity indices in the world - equivalent to the Dow Jones Industrial Average or the S&P 500 for stocks. The S&P GSCI is weighted by global physical commodity production. The DJ-UBSCI employs a similar methodology but imposes restrictions on the maximum (and minimum) weight of a sector or individual commodity and incorporates contract liquidity into weight calculations.

4 Data and Method

The methodology in this paper closely follows that of Tang and Xiong because of its proximity in terms of research area. The core of the methodology used by Tang and Xiong is based on regressions of the daily returns of a pooled time-series dataset of 24 non-energy commodities on oil price returns. I have decided to use a similar method for my regressions with a few alterations described in greater detail in section 4.1.

I use data from Datastream comprising daily closing prices for 25 commodity futures spanning the thirty years between Jan 1st 1984 and Jan 1st 2014. I use Datastreams continuous futures series with the CS00 suffix indicating that futures contracts are rolled on the first day of the new month trading and that all available month contracts are used.[10] Daily contract volumes are also obtained for the same futures series.

Important to note is that I do not use the exact same set of commodities as Tang and Xiong. I am unable to obtain data on any of the commodities included in the soybean complex and contrary to Tang and Xiong I am able to obtain data on the industrial metals traded on the London Metal Exchange (LME).[11] I chose to deviate from Tang and Xiong's methodology on this point because these industrial metals are significant constituent commodities in both the S&P GSCI and the DJ-UBSCI. The inclusion of these commodities will only serve to make my group of indexed commodities a closer approximation of the actual indices. The addition of data from the London Metal Exchange is consistent with Gorton and Rouwenhorst (2006) who complemented their original Commodities Research Bureau dataset with data from the LME. Table 4.1 shows a complete list of the commodities used in this paper. The on-index commodities are simply all available commodities futures contracts which are constituents of either the S&P GSCI or the DJ-UBSCI indices. The list of off-indexed commodities has been obtained entirely from Tang and Xiong in order to facilitate more accurate comparisons.

[10] Datastream offers six different types of roll methodologies based on specific roll days, trading volumes or averages. There are also two different types of trading cycles to choose from which differ in the selection of contract maturities. Type CS will use all available month contracts (every month of the year for most contracts) whilst Type CT will use the traditional trading cycle of contracts (March, June, September and December for many contracts).

[11] Commodities included in the soybean complex include soybeans, soybean meal and soybean oil. The industrial metals traded on the London Metal Exchange which I include are Aluminium, Copper, Lead, Nickel, Tin and Zinc.

Tang and Xiong use a dataset obtained from Pinnacle Data Corporation and create their own futures contract rolls. They create portfolios in which each futures contract is held until the 7th calendar day of its maturity month at which point they roll their position onto the next months futures contract. This methodology of creating a return index from rolling futures contracts follows prior research from Gorton and Rouwenhorst (2006) and Erb and Harvey (2006).

Rolling the futures contract on a single calendar day of each month is a compromise between mimicking the S&P GSCI and DJ-UBSCI commodity indices and methodological simplicity. The indices actually roll their constituent futures contracts in 20% increments between the 5th and 9th business days of rolling months. The S&P GSCI rolls its futures contracts every month and the DJ-UBSCI rolls its futures contracts every other month. Granted, my methodology is slightly different from that of Tang and Xiong but my attempts to replicate their results suggest that this methodological difference has little impact as my results were very similar. It is worth noting that Gorton and Rouwenhorst (2006) also roll their futures contracts on the first day of the month as opposed to the 7th.

I calculate the return on any given day as:

$$R_{i,t} = \ln\left(F_{i,t}\right) - \ln\left(F_{i,t-1}\right) \tag{1}$$

or simply the difference between the natural logarithms of the date-t price of commodity i's future and the price on the previous day. Like Tang and Xiong I also normalize all my returns by the respective sample mean and standard deviation for each individual commodity:

$$R^n_{i,t} = \frac{R_{i,t} - \mu_i}{\sigma_i} \tag{2}$$

Because my data stretches past the financial crisis, my normalized returns will be different from those of Tang and Xiong, even for the exact same dates. This is because the volatility of returns during the financial crisis was significantly higher than for the period before the crisis (as shown in graph 5.2), which impacts the normalization process across the entire dataset. Of course, for my initial replication of Tang and Xiongs analyses, the returns were normalized over a shorter period so as to produce a more accurate replication.

4.1 Regressions

The core analyses made in this paper are based upon regressions of a pooled time-series dataset of the 24 non-energy commodities outlined in Table 4.1 on the oil price. As most of the commodities are traded in the U.S., I have chosen the West Texas Intermediate (WTI) crude oil price for my main regression independent variable. This follows the methodology of Tang and Xiong and although one could argue that the Brent crude oil price is a more accurate global oil benchmark, the WTI futures are the most liquid commodity futures contracts in the world. WTI also represents a larger share of the S&P GSCI and DJ-UBSCI indices. Erb and Harvey (2006) report that in May of 2004, the S&P GSCI (then simply the GSCI) represented 86% of the combined open interest of the three largest commodity indices in the world. The DJ-UBSCI represented 10% of the combined open interest with the remaining 4% accounted for by the Reuters-CRB index. WTI crude oil has historically accounted for a very large portion of the S&P GSCI, often between 30% and 40%, and therefore serves as a good dependent variable for measuring the effects of index investing.

To decompose the oil price return coefficient, I use several different indicator (dummy) variables. These can be split into two groups consisting of year-variables and year-index variables. A year-variable will be equal to one if an observation comes from the corresponding year. For example, a 2009-year-variable will be equal to one if the year is 2009 and will be equal to zero otherwise. A year-index variable will be equal to one if an observation comes from the corresponding year and if the commodity is part of either the S&P GSCI or the DJ-UBSCI indices. For example, a 2009-year-index variable will be equal to one if the year is 2009 and if the commodity for that particular observation is part of either the S&P GSCI or the DJ-UBSCI indices. My main regression includes year- and year-index variables for 2008 to 2013, resulting in twelve different indicator variables. This regression is set up as follows:

$$\begin{aligned} R_{i,t}^{n} = \alpha + [\beta_0 \quad &+ \quad \beta_1 I_{2008} + \beta_2 I_{2008} I_{index} \\ &+ \quad \beta_3 I_{2009} + \beta_4 I_{2009} I_{index} \end{aligned} \tag{3}$$

$$
\begin{aligned}
&+ \quad \beta_5 I_{2010} + \beta_6 I_{2010} I_{index} \\
&+ \quad \beta_7 I_{2011} + \beta_8 I_{2011} I_{index} \\
&+ \quad \beta_9 I_{2012} + \beta_{10} I_{2012} I_{index} \\
&+ \quad \beta_{11} I_{2013} + \beta_{12} I_{2013} I_{index}] R^n_{oil,t}
\end{aligned}
$$

Where $R^n_{i,t}$ is the normalized return of commodity i on date t. This regression set up allows for the decomposition of the regression coefficient into several different components. It is a very informative set up because it clearly shows what portion of the correlation between a given commodity return and the oil price return stems from base correlation before the financial crisis, increased correlation during or after the financial crisis, or incremental correlation attributable to a commodity's inclusion in either the S&P GSCI or the DJ-UBSCI.

In addition to the above set-up, I perform regressions with the time period indicator variables consolidated to either before or after the Lehman Brothers bankruptcy as well as before or after 2003, which is the year that financialization of commodities is widely regarded to have started.

$$
R^n_{i,t} = \alpha + [\beta_0 + \beta_1 I_{postLehman} + \beta_2 I_{postLehman} I_{index}] R^n_{oil,t} \tag{4}
$$

and

$$
\begin{aligned}
R^n_{i,t} = \alpha + [\beta_0 \quad &+ \quad \beta_1 I_{post2003} + \beta_2 I_{post2003} I_{index} \\
&+ \quad \beta_3 I_{postLehman} + \beta_4 I_{postLehman} I_{index}] R^n_{oil,t}
\end{aligned} \tag{5}
$$

These regressions are less informative because they bundle the crisis years together as a single period such that strongly increasing correlations during the early crisis years may cloud conclusions of stagnant correlations during the later crisis years. As such, these will not be the focus of my discussion in this paper but I have included them nonetheless because they highlight some important issues and provide good overview of correlations during the financial crisis. Importantly, the decomposition of correlation coefficients by year distinguishes my methodology from that of Tang and Xiong who examine their chosen period as a whole. It is this decomposition that facilitates the discovery of my most important and interesting results which I discuss further in sections 5 and 6.

In order to control for supply and demand fundamentals which could theoretically interfere with the correlations observed from regression I, I perform two additional regressions in which I extend the set-up from regression I by also controlling for returns of the MSCI Emerging Markets index and returns of the S&P 500 index (see tables 5.2 and 5.3). These serve as proxies for emerging market and U.S. commodity demand, respectively and are also decomposed by year- and year-index indicator variables. This is consistent with the method of Tang and Xiong. Lastly, I perform a regression in which I control for all three independent variables simultaneously (see table 5.4).

5 Results

5.1 Commodities and Oil Price Correlation

Graph 5.1 displays average commodity prices for my sets of on-index and off-index commodities, with prices indexed to 100 in 1985.[12] Comparatively, prices seem idle between 1985 and 2004 despite several periods of seemingly impressive growth such as 1987-1990 and 1993-1995. Off-index commodities display a more volatile behavior with higher peaks and lower troughs during the period before 2004. Indeed, Graph 5.2 shows that the average 1-year rolling standard deviation of off-index commodities was markedly higher than that of on-index commodities between 1990 and 2003. In early 2003 however, the two converged before a period of higher volatility for on-index commodities. This shift coincides perfectly with the start of the financialization of commodities markets as described by Tang and Xiong.

Graph 5.3 shows the average 1-year rolling oil price correlation for the two sets of on-index and off-index commodities. Again, the period between 1985 and 2004 seems quite stable with oil price correlation rarely breaching 10% for either of the two sets. However, the low point in early 2004 marks the start of an upward trend for both on-index and off-index commodities although the former is of a larger magnitude. On-index oil price correlation peaks at 22% before falling back in early 2007. However, as tensions in the financial markets started to rise in early 2008 so did oil price correlation for both on-index and off-index commodities. By the time Lehman Brothers filed for bankruptcy protection, on-index oil price correlation had already reached a new high of 23.5%. It climbed almost 20 percentage points further before peaking at 41% in late 2008. Off-index oil price correlation settled almost 10 percentage points lower before slowly starting to converge with its on-index counterpart in 2010.

5.2 Index Investing

As mentioned in section 3.4, the CFTC issues a special call every month to the largest known swap dealers and index traders requiring them to report the notional amounts and corresponding numbers of futures contracts characterized as index

[12]See table 4.1 for a complete list of the on-index and off-index commodities used in this paper as well as the corresponding weights in the S&P GSCI and the DJ-UBSCI.

investments. This data encompasses 21 different commodities for all markets with reported net notional amounts greater than $500 million. Unsurprisingly, all but one of these commodities are classified in this paper as on-index commodities. Nevertheless, the data provides some insights well worth mentioning.

Graph 5.4 shows the total values of U.S. index investing into the above mentioned 21 commodities between 2007 and 2013. The dashed gray line shows real amounts in fixed 2007 prices representing a more accurate view of the development of index investing, unbiased by the impact of dramatically rising or falling commodity prices. This bias is perhaps most articulated during the dramatic fall in index investing between June and December 2008 when nominal amounts declined by almost 60% whilst real amounts declined by only 16%. Nevertheless, both real and nominal amounts show a distinguished and increasing trend in the period between early 2009 and 2011 during which they increased by 62% and 195%, respectively. After 2011, both real and nominal amounts have been largely unchanged at roughly $150 billion.

It is important to note that this set of 21 commodities does not represent the majority of commodity index investing today. The S&P GSCI and the DJ-UBSCI report that an estimated $230 and $75 billion[13], respectively tracked the two index families as of 2013. This is more than double the amounts reported in the CFTC reports, largely attributed to the increasing range of commodities that investors want to hold. From their beginnings in the 1980s and 90s, the S&P GSCI and DJ-UBSCI families of commodity indices have grown to now encompass 51 and 56 separate indices, respectively in order to accommodate the highly specific exposures desired by many investors.

As shown in Table 4.1, the S&P GSCI and DJ-UBSCI indices jointly cover 26 commodities as of 2014 separated into three sectors as follows:

- Energy (6 commodities)
- Metals (7 commodities)
- Agriculture (13 commodities)

As of April 2014, the CME Group website reports open interest in 446 different commodity futures contracts split between each sector as follows:

[13] Amounts reported in each of the two index operators 2014 weights press releases.

- Energy (401 contracts)
- Metals (15 contracts)
- Agriculture (30 contracts)

Granted, many of these contracts (especially in the energy sector) are derivative products of an underlying commodity included in either of the two indices and as such do not represent unique commodities. Nevertheless it seems that commodity investing has grown more in width than in height in recent years.

A good example of this diversification effort among commodity investors is investment into wheat futures. Historically, Chicago wheat has been the dominant futures contract held by most investors with exposure to wheat markets. More formally known as soft red winter wheat, Chicago wheat is a high-yielding, low-protein wheat most often used in pastries, cakes, flat breads and different types of baking flour. A smaller share of the wheat market has been held by so called Kansas wheat, more formally known as hard red winter wheat. It is a versatile medium-protein wheat used for bread, hard-baked goods, noodles and general purpose flour. CFTC index investment reports show that in December 2007, open interest in wheat contracts amounted to 211,000 contracts split between Chicago wheat and Kansas wheat with 185,000 and 26,000 contracts, respectively. Graph 5.5 shows the share of index investment into Kansas wheat as a percentage of total index investment into wheat as reported by the CFTC reports, between 2007 and 2013. From a low of less than 10% in March 2008, the share of Kansas wheat has grown steadily to 28.6% in December 2013. Even more importantly, this growth has occurred despite a stagnant relative share of physical production, implying that the shift has been caused not by supply and demand fundamentals but by other factors such as a desire among investors to diversify wheat exposures.

Although not perfectly analogous, an examination of the shares of energy sector index investment into crude oil and natural gas paints a similar picture. Graph 5.6 shows that since 2007, natural gas has grown from below 20% of energy sector index investment to just below 40% in 2013. During the same period, crude oil has fallen from above 60% of energy sector index investment to just above 40% in 2013[14]. Similar to Kansas wheat, the rise of natural gas has occurred despite a

[14] Based on fixed 2007-level prices.

falling share of physical production as indicated by its weight in the production-weighted S&P GSCI. From 2008 to 2014, natural gas has fallen from 7.4% to 2.6% of the S&P GSCI.

Unfortunately, limited availability of data precludes further analyses of this sort. These examples, therefore, serve merely as illustrations of a point which I will discuss more thoroughly in the next section where I use regression analysis to infer more statistically robust conclusions.

5.3 Univariate Regression Analysis

As described in section 2, Tang and Xiong exhaustively investigated the prevalence of financialization in commodities markets for the period leading up to the financial crisis. In this section, I employ a similar methodology to extend this analysis to the period after the financial crisis. More specifically, I use a pooled dataset comprising normalized returns on 24 different commodities. I use daily returns for all commodities between January 1st 1998 and Jan 1st 2014 for a total of 119,675 observations. I then match every observation with the corresponding normalized oil price return for that same date. I set up regression I as follows:

$$
\begin{aligned}
R_{i,t}^{n} = \alpha + [\beta_0 \quad &+ \quad \beta_1 I_{2008} + \beta_2 I_{2008} I_{index} \\
&+ \quad \beta_3 I_{2009} + \beta_4 I_{2009} I_{index} \\
&+ \quad \beta_5 I_{2010} + \beta_6 I_{2010} I_{index} \\
&+ \quad \beta_7 I_{2011} + \beta_8 I_{2011} I_{index} \\
&+ \quad \beta_9 I_{2012} + \beta_{10} I_{2012} I_{index} \\
&+ \quad \beta_{11} I_{2013} + \beta_{12} I_{2013} I_{index}] R_{oil,t}^{n}
\end{aligned}
$$

The regression is set up such that β_0 represents the base oil price correlation between 1998 and 2013 for all the 24 commodities. The oil price correlation for any given off-index commodity will therefore equal β_0 plus the coefficient corresponding to that particular years year-indicator variable. For instance, the oil price correlation for an off-index commodity in 2010 will equal β_0 plus β_5. In order to measure the impact of index investing, I have also added year-index-indicator variables which show the incremental oil price correlation for commodities included in either the S&P GSCI or the DJ-UBSCI. As such, the oil price correlation for any given on-index commodity will therefore equal β_0 plus the coefficient corresponding to that particular years year-indicator variable as well as the coefficient corresponding to the same years year-index-indicator variable. For instance, the oil price correlation for an on-index commodity in 2010 will equal β_0 plus β_5 plus β_6.

Panel A in table 5.1 reports the results of regression I. Unsurprisingly, β_0 is positive and highly significant with a coefficient of 0.0579 and a corresponding t-statistic of 15.22. This is largely consistent with graph 5.3 discussed in section 5.1. The coefficients for the year-indicator variables are all highly positive and significant for all years but 2013. Much as expected, this proves that oil price correlation did indeed spike during the financial crisis. The lack of a significantly higher oil price correlation for 2013 is interesting as it signifies a significant break from the prevailing pattern of the post-crisis years. A definite conclusion on whether oil price correlation is once again back at pre-crisis levels or even pre-financialization levels is a matter of future research as additional data is required. Nevertheless, I discuss this finding further in section 6.2.

An examination of the year-index-indicator variables reveals a more surprising pattern. β_2 and β_4 are both positive and highly significant. They show that on-index commodities did indeed have higher oil price correlations than their off-index counterparts for 2008 and 2009. Off-index oil price correlations were 26% and 18% for 2008 and 2009, respectively whilst on-index oil price correlations were 34% and 30% for 2008 and 2009, respectively. These findings are very much consistent with those of Tang and Xiong. However, the year-index-indicator variables for 2010 to 2013 are all lower in magnitude and more importantly, statistically insignificant for high confidence levels. This implies that after 2009, there is no statistically significant difference in the oil price correlations of on-index and off-index commodities.

To examine this pattern further and to show the importance of decomposing the period into individual years, I set up two additional regressions. Regression II is set up as follows:

$$R^n_{i,t} = \alpha + [\beta_0 \quad + \quad \beta_1 I_{postLehman} + \beta_2 I_{postLehman} I_{index}] R^n_{oil,t}$$

Regression III is set up as follows:

$$\begin{aligned} R^n_{i,t} = \alpha + [\beta_0 \quad &+ \quad \beta_1 I_{post2003} + \beta_2 I_{post2003} I_{index} \\ &+ \quad \beta_3 I_{postLehman} + \beta_4 I_{postLehman} I_{index}] R^n_{oil,t} \end{aligned}$$

Both regressions are similar in structure to regression I with the only changes being the way in which time periods are examined. Regression II has only two time periods; before the collapse of Lehman Brothers (β_0), and after the collapse of Lehman Brothers (β_1). Regression III has a similar set-up but splits the pre-Lehman period into pre- and post-financialization of commodities, as indicated by β_0 and β_1, respectively. Both regressions have index-indicator variables for each separate time period.

Panels B and C in table 5.1 report the results of regressions II and III, respectively. Regression II supports the initial conclusions from regression I that oil price correlations were indeed higher during the financial crisis and that on-index commodities displayed incrementally higher oil price correlations than their off-index counterparts. Regression III confirms the results of Tang and Xiong by showing that oil price correlations were indeed higher after 2003 and once again that on-index commodities displayed incrementally higher oil price correlations than off-index commodities during that period.

It is important to note that this set-up clouds what is arguably the most interesting conclusion from regression I by examining the financial crisis as one single period. Both β_2 in regression II and β_4 in regression III are positive and highly significant, suggesting that the difference in oil price correlations between on-index and off-index commodities was greater than zero for the entire period. By breaking down the post-crisis period into each individual year, we are able to more accurately observe the effects of financialization.

5.4 Multivariate Regression Analysis: MSCI Emerging Markets

Drawing on the findings from section 5.3, I set up a new regression similar to regression I but which controls also for the normalized returns of the MSCI Emerging Markets (MSCIEM) equity index. To make the independent variables comparable, I decompose the MSCIEM coefficient in the same way I decompose the oil price returns coefficient i.e. by year-indicator variables and year-index-indicator variables. This rather lengthy but fairly straightforward regression is set up as follows:

$$
\begin{aligned}
R^n_{i,t} = \alpha + [\beta_0 &+ \beta_1 I_{2008} + \beta_2 I_{2008} I_{index} \\
&+ \beta_3 I_{2009} + \beta_4 I_{2009} I_{index} \\
&+ \beta_5 I_{2010} + \beta_6 I_{2010} I_{index} \\
&+ \beta_7 I_{2011} + \beta_8 I_{2011} I_{index} \\
&+ \beta_9 I_{2012} + \beta_{10} I_{2012} I_{index} \\
&+ \beta_{11} I_{2013} + \beta_{12} I_{2013} I_{index}] R^n_{oil,t} \\
+[\gamma_0 &+ \gamma_1 I_{2008} + \gamma_2 I_{2008} I_{index} \\
&+ \gamma_3 I_{2009} + \gamma_4 I_{2009} I_{index} \\
&+ \gamma_5 I_{2010} + \gamma_6 I_{2010} I_{index} \\
&+ \gamma_7 I_{2011} + \gamma_8 I_{2011} I_{index} \\
&+ \gamma_9 I_{2012} + \gamma_{10} I_{2012} I_{index} \\
&+ \gamma_{11} I_{2013} + \gamma_{12} I_{2013} I_{index}] R^n_{MSCIEM,t}
\end{aligned}
$$

The rationale behind this set-up is that the inclusion of MSCIEM index returns captures the fundamental supply and demand factors from emerging market countries which impact the prices of commodities. For instance, the effects of a surge in Chinese demand for aluminium in 2009 would be captured by γ_3 and γ_4 rather than β_3 and β_4 and would therefore lead to a better estimation of the correlation increases caused purely by financialization.

Panel D in table 5.2 reports the results of regression IV. An initial examination of the results shows that the t-statistics for most coefficients from regression I are lower. In fact, the increased correlation for all commodities during 2009, β_3 is no longer statistically significant and the magnitudes of β_1, β_5, β_7, β_9 and β_{11} have all been significantly lowered. However, the overall conclusion that oil price correlations were higher during the financial crisis is still intact. Similarly, the t-statistics for most of the year-index-indicator variables are all lower than in regression I but the conclusion remains the same - that there is no difference in oil price correlations among on-index and off-index commodities after 2009.

The coefficients relating to the MSCIEM returns (γ_0-γ_{12}) provide few additional insights. Unsurprisingly, commodities have a fairly high base correlation to MSCIEM returns (≈9%) which increases during the financial crisis much in the same way as for oil price returns. There is no observable increase in correlation for on-index commodities also rather predictable considering the size and diversification of the MSCIEM.[15] Note that MSCIEM returns are not included as a means to explain variation in commodity returns but rather to capture non-financialization variation in commodity returns. As such, the point of interest is not the MSCIEM coefficients themselves but rather the impact they have on oil price coefficients. I conclude that the inclusion of MSCIEM returns, whilst understandably deleterious to t-statistics and thereby significance levels, leaves the overall conclusion from regression I intact.

5.5 Multivariate Regression Analysis: S&P 500

Another important factor in determining commodity prices is fundamental supply and demand from the U.S. market. I therefore set up a fifth regression identical in structure to regression IV but with the normalized returns of the S&P 500 as the controlling variable rather than MSCIEM returns.

Panel E in table 5.3 reports the results of regression V. Overall, the results are very similar to those from regression IV. The magnitudes and t-statistics of the oil price coefficients have been lowered albeit not as much as in regression IV. It seems that S&P 500 returns are less effective at explaining variation in commodity returns than MSCIEM returns. Indeed, the base correlation between S&P 500 returns and commodity returns is a mere 4.3% and the year-indicator variables are barely statistically significant and of lower magnitudes. However,

[15]The MSCI website reports that the MSCIEM currently includes more than 800 securities from 21 different markets, constituting approximately 11% of global market capitalization.

this can hardly be an unforeseen conclusion considering the less diversified nature of the S&P 500.[16]

Once again, the inclusion of a control variable has failed to alter the interpretation of regression I. β_2 and β_4 are still economically and statistically significant whilst the rest of the year-index-indicator oil price coefficients remain below acceptable significance levels.

5.6 Multivariate Regression Analysis: Combined

To ensure the validity of my conclusions thus far, I set up one final regression controlling for MSCIEM returns and S&P 500 returns simultaneously. It makes intuitive sense to control for both emerging market and U.S. commodity supply and demand factors in order to extricate correlation caused purely by financialization. This set-up should result in the most accurate measurement of correlation caused by financialization.

Panel F in table 5.4 reports the results of regression VI. Overall the results are very similar to those of regressions I, IV and V. Oil price year-indicator coefficients remain, for the most part, statistically and economically significant. The incremental oil price correlation for on-index commodities during 2008 and 2009, as represented by β_2 and β_4, have proven remarkably robust to the inclusion of control variables. Similarly, incremental oil price correlation for on-index commodities between 2010 and 2013 are once again below acceptable significance levels, thereby supporting the findings from previous regressions.

Almost all coefficients relating to either MSCIEM returns or S&P 500 returns are below acceptable significance levels in this regression. The major exception is the base correlation between commodity returns and MSCIEM returns which has remained highly significant in both statistical and economic terms. However, it is the resilience of the oil price coefficients to the inclusion of control variables that is the main point of interest in this regression.

Confident that the drop in incremental oil price correlation for on-index commodities after 2009 was not caused by fundamental supply and demand factors, I

[16]The S&P 500 is weighted by market capitalization and according to the S&P month-end report for March 2014, the ten largest constituents make up 17.9% of total value. The single largest constituent, Apple Inc., had a weight of 2.9% as of March 31, 2014. An estimated $5.74 trillion is benchmarked to the index which reportedly covers 80% of U.S. market capitalization.

will now investigate this pattern further by separately examining trading volumes for on-index and off-index commodities.

5.7 Development of Trading Volumes

One of the most intuitive signs of financialization is highly increasing trading volumes. As investors discover a new and unexploited market, the monetary flows into the sector push trading volumes upward. With this line of thinking in mind, I decided to examine the trading volumes of my two sets of on-index and off-index commodities. Graph 5.7 reports yearly trading volumes, indexed to 100 in 2001 and averaged across each of my two sets of commodities. The graph paints a very interesting picture.

In 2002 and 2003, the trading volumes of on-index and off-index commodities are indistinguishable from one another. In 2004 however, trading volumes for on-index commodities rose to 154 compared to 133 for off-index commodities. This marked the beginning of a trend in which trading volumes for on-index commodities grew much faster than trading volumes for off-index commodities. Interestingly, the start of this trend coincides perfectly with the start of financialization as described by Tang and Xiong. Even more interesting is the fact that the end of the above mentioned trend coincides perfectly with the drop in incremental oil price correlation for on-index commodities as first described in section 5.3.

To examine the statistical significance of these findings I performed three two-tailed t-tests, the results of which are presented in table 5.5. All three t-tests have the same hypotheses and differ only in the time period for which the relationship is examined. H_0 posits that the indexed volumes for on-index commodities are equal to the indexed volumes for off-index commodities. The alternative, H_a, posits that the volumes are not equal.

Panel G reports the results from the first test, testing the hypotheses for the period 2001 to 2013. With a p-value of 0.1069, I conclude that H_0 cannot be rejected for any acceptable significance level. Panel H reports the results from the second test, testing the hypotheses for the period 2004 to 2009. With a p-value of 0.0000, I conclude that H_0 can indeed be rejected for all significance levels. This implies that trading volumes were significantly higher for on-index commodities between 2004 and 2009. Panel I reports the results from the last test, testing the hypotheses for the period 2010-2013. With a p-value of 0.2130, I conclude that

H_0 cannot be rejected for any acceptable significance level.

6 Discussion

6.1 Maturing Commodities Markets

The results from sections 5.1 through 5.7 display an interesting pattern. In particular, the equalization of oil price correlation for on-index and off-index commodities and its perfect coincidence with the relative equalization of trading volumes between the two groups suggest one of three immediately apparent hypotheses:

1. Financialization has disappeared from commodities markets

2. The post-crisis period is experiencing a temporary lapse in the financialization of commodities markets

3. Financialization has spread to the outer (off-index) areas of commodities markets

Although seemingly unlikely, there are a few arguments for accepting hypothesis I. Most importantly, the equalization of oil price correlation for on-index and off-index commodities reverts to the pre-financialization trend of the early 2000s. A second and somewhat overlooked point that I will discuss further in section 6.2 is that none of the regressions above are able to show a statistically significant increase in oil price correlation for 2013. That is, we cannot say that oil price correlation for 2013 is higher than the 1998 through 2007 average. Despite these points, we know from section 5.2 that index investing into commodities is still very much a staple of prudent portfolio diversification and that the sector is still very large. With this in mind, we cannot reasonably accept the premise that financialization has somehow disappeared from commodities markets.

Hypothesis II, though not entirely implausible, is ultimately impossible to prove at this time. Such a study would require several years of additional data. I must therefore leave any material conclusions on the matter for future research.

Hypothesis III makes more intuitive sense and has greater empirical support. After all, it is only natural that the quest for diversification which initially lured investors to commodities would eventually lead them to exploit also the peripheral areas of this new sector. It is understandable that the first years of the commodities boom saw funds flowing mostly into the largest and most liquid commodities contracts. At the time, they all seemed to provide the same level of diversification so there was no reason to invest in outlying, illiquid commodities. However, as the financialization of commodities markets came to light, these fringe commodities became more attractive as they did indeed provide superior diversification benefits. The wheat example from section 5.2 strongly speaks to this point, as does the widening of commodities markets as illustrated by the variety of contracts traded through the CME Group and the large number of highly specific sub-indices within the S&P GSCI and DJ-UBSCI families of commodity indices. John Kemp of Reuters News wrote in 2011 that the futures risk premium so enthusiastically praised by Gorton and Rouwenhorst (2006), disappeared shortly after their paper was published as investors moved en masse into commodities.[17]

Perhaps even more important was the shift in the structure of commodities markets as a result of their financialization. Recall from section 3.3 that the roll yield on a futures contract would be consistently positive only if a market was in backwardation and that the opposite, contango, would result in negative roll yields. As it turned out, the surging demand for long-only investments into commodity futures drastically changed the futures curve from a state of seemingly perpetual backwardation to its current state of contango. The transformation of the roll gain into a roll loss has weighed heavily on commodity index returns in recent years. Kaplan (2010) shows that long-only commodity indices are often adversely affected by contangoed futures markets and argues that investors should adopt more advanced strategies in light of the changing market structure. Indeed, graph 5.8 shows the total returns of the S&P GSCI and DJ-UBSCI indices between 1991 and 2013. The last few years show stagnant or even declining returns, partly attributable to a negative roll yield. Few institutional investors tolerate such consistently poor returns and many have started to look for alternatives to the traditional long-only index style of investing.

The above mentioned combination of declining diversification benefits and negative roll yields has lead investors towards longer-maturity contracts (where roll yields might still be positive) and more exotic and unexploited commodities (where diversification benefits might still be high). Kurt J. Nelson, former head of commodity index investing at UBS, described the situation as follows when interviewed by Reuters in 2010:[18]

[17]"Commodity indices struggle against the tide", John Kemp, 2011-06-14, Reuters News

[18]"FUNDVIEW - SummerHaven sees more active commodity investment", David Sheppard, 2010-01-18, Reuters News

"A hands-off approach might give investors exposure to commodities but it is not necessarily maximizing returns. It is natural that for the first five to ten years, investor interest is based on the most simple, easy-to-understand benchmarks, and now its natural for them to move towards a more active style of investment and asset management."

Mr Nelson's firm, SummerHaven Investment Management, operates commodity indices with more advanced strategies.[19] Its SummerHaven Dynamic Commodity Index (SDCI) rebalances on a monthly basis and selects 14 out of 27 different commodities based on, among other things, the slope of the futures curve. Investors are showing increasing interest for these types of actively managed commodity funds. A poll by Barclays Capital from 2010 found that 20% of responding commodity investors preferred active strategies of commodity investing such as those employed by SummerHaven. The same poll conducted in 2011 found that the fraction had risen to 60%.[20]

The rise of active commodity investing offers a clear and intuitive explanation for the results presented in section 5. It is a strong signal of the maturation of commodities markets where simply having exposure no longer guarantees success. Much like equity or fixed income markets, consistently high returns from commodities investing now relies upon superior asset management, often achieved by utilizing a wider range of commodities and maturities. SummerHaven's SDCI has generated an average annual return of 13.48% in the last 10 years compared to 3.00% and 2.08% for the S&P GSCI and DJ-UBSCI, respectively. In fact, a study by Barclays Capital from 2011 found that actively managed commodity funds have consistently outperformed their long-only index counterparts since 2004.[21] This trend has important implications for numerous stakeholders, though it is perhaps most significant for regulatory bodies such as the CFTC whose outdated definition of on-index commodities encompasses barely half of the actual market.

[19] Incidentally, among the other founders of SummerHaven Investment Management is Geert Rouwenhorst, one of the pioneering academics of commodities investing as described in section 2.

[20] "Pendulum swings to active investing in commodities", Chris Flood, 2011-03-24, Financial Times

[21] "Wide range of commodities vehicles deliver varying results", Ajay Makan, 2011-12-04, Financial Times

6.2 A Fall in Correlation

The second most important finding from section 5 is the reversion of oil price correlation in 2013. Although the data is not sufficient for any solid conclusions, the trend may be indicative of a structural change in commodities markets. Mechanically, the reversion is explained by the combination of declining commodity prices, as shown in Graph 5.1, and a stagnant oil price. The latter can be explained by surging domestic crude production in the U.S. combined with bottlenecks in its mid- and downstream infrastructure. An explanation for the drop in commodity prices is less clear-cut. Some suggest it was an expected outcome following the end of the commodity supercycle while others point to falling demand from emerging markets. In particular, fears about Chinese growth seem to have weighed on prices, compounded by increasing production capacities indicative of future supply gluts in many commodity subsectors. Whatever the reason, it suggests that the impact of financial investors in the pricing of commodities has decreased, or at the very least that index investing has a diminished influence over commodity prices. This development should be welcomed by producers, investors and regulators alike but only time will tell if it is a lasting change.

7 Conclusion

In this paper, I have studied the development of oil price correlation for a set of 24 commodities in order to examine the impact of commodity index investing on the pricing of commodities after the financial crisis. My methodology is largely based upon previous work by Tang and Xiong (2012) and focuses on regressions of pooled commodity returns on oil price returns.

I find that there is a significant break in the pre-crisis trend after 2009 where oil price correlation is no longer higher for on-index commodities than for off-index commodities. As correlation remains high for most of the period, this suggests an equalization of the effects of financialization between the two groups. This, in turn, suggests that commodity index investing has grown in width to include a more complete set of commodities as investors look for unexploited areas of the sector to combat declining returns.

I argue that this signals the maturation of commodities markets in which active asset management plays a more important role. This contrasts the passive, long-only style of investment that has characterized commodity investing for the last 20 years and marks a significant change in the world of commodity investing.

8 Limitations

The results presented in this study are based largely on changes and differences in oil price correlation for a set of non-energy commodities. Of course, mere correlation does not prove causality between two variables. However, for the initial examination of financialization, I am more interested in proving that there is correlation than I am explaining its origination, although this paper does deal with both issues.

I am also aware that some areas of my argumentation in section 6 may seem far-fetched due to the lack of academic research on the topic. However, I remain confident in my conclusions as there is ample support from practitioners and non-academic researchers.

My data also poses a few issues. The main issue is that I am unable to access data on the soybean complex, thereby excluding three commodities from my sample. The limited data availalbe from the CFTC also precludes some potentially important results regarding index investing.

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Tables and Graphs

Attached below are all tables and graphs referenced in the previous sections. They appear in chronological order and are named according to the section in which they are first referenced as well as their relative order within that section. All tables and graphs have a self-contained caption displayed above the corresponding table or graph.

Table 4.1

This table lists all examined commodities along with the exchange on which each commodity is traded and weights in the S&P GSCI and DJ-UBSCI for 2008 and 2014 (all weights obtained from relevant index operator press releases). Commodities without listed index weights are considered off-index commodities for the purpose of this study.

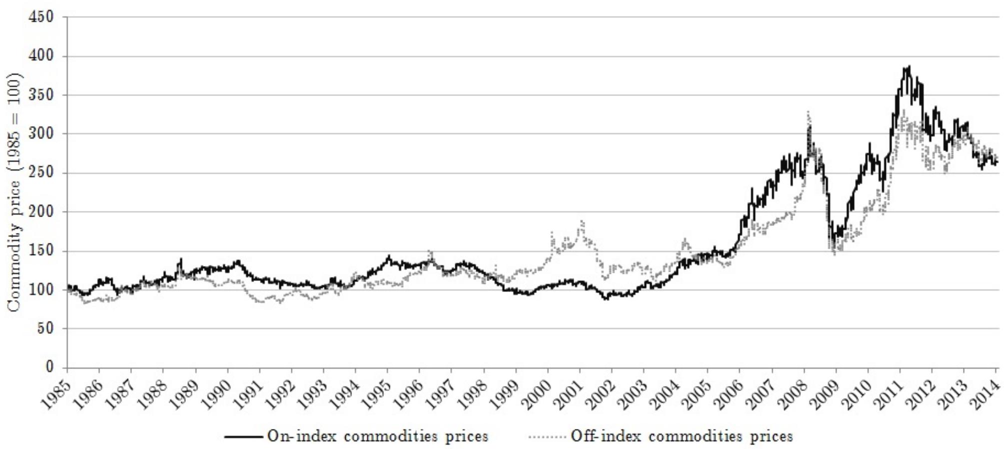
Commodity	**Exchange**	**Index Weight(%)**			
		S&P GSCI		**DJ-UBSCI**	
		2008	2014	2008	2014
Energy					
WTI Crude	NYMEX	38.0	23.7	13.2	8.5
(Other Energy*	NYMEX/ICE	35.6	46.0	19.8	23.3)
Metals					
Aluminium	LME	2.6	2.0	7.1	4.7
Copper	LME	3.3	3.2	7.0	7.5
Lead	LME	0.5	0.5	0.0	0.0
Nickel	LME	0.9	0.5	2.8	2.1
Zinc	LME	0.6	0.5	3.0	2.3
Gold	NYMEX	1.9	2.8	7.4	11.5
Silver	NYMEX	0.3	0.4	2.7	4.1
Platinum	NYMEX				
Palladium	NYMEX				
Agriculture/Other					
Chicago Wheat	CBOT	4.1	3.5	4.7	3.3
Kansas Wheat	CBOT	1.0	0.8	0.0	1.2
Corn	CBOT	3.6	4.9	5.7	7.2
(Soybean Complex**	CBOT	2.0	2.9	10.4	11.2)
Cotton	ICE	0.8	1.0	2.5	1.6
Sugar No. 11	ICE	1.0	1.5	3.2	4.0
Coffee	ICE	0.5	0.6	3.0	2.3
Cocoa	ICE	0.2	0.2	0.0	0.0
Live Cattle	CBOT	1.8	2.8	4.9	3.3
Feeder Cattle	CBOT	0.4	0.5	0.0	0.0
Lean Hogs	CBOT	1.0	1.7	2.6	1.9
Minnesota Wheat	MGE				
Rough Rice	CBOT				
Oats	CBOT				
Lumber	CBOT				
Orange Juice	ICE				
Sum		100.0	100.0	100.0	100.0

* Consists of Brent Crude, RBOB Gas, Heating Oil, GasOil and Natural Gas.

** Consists of Soybeans, Soybean Oil and Soybean Meal. Data not available.

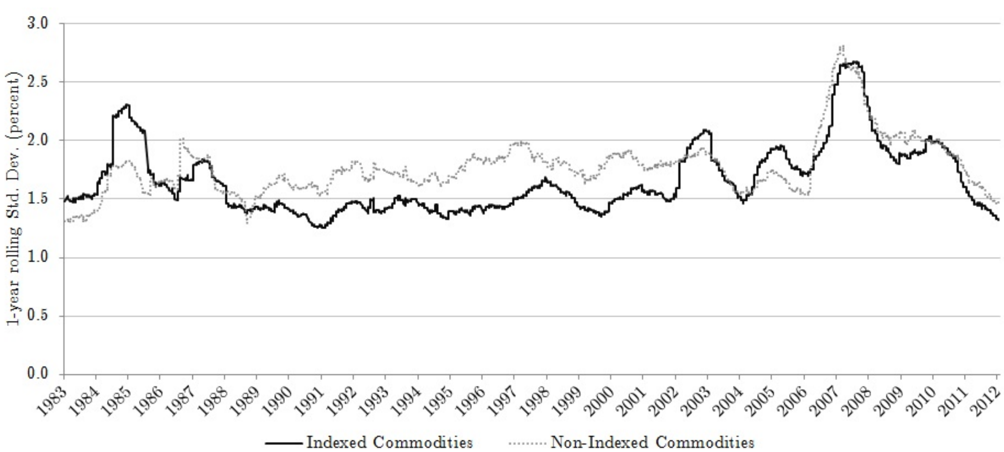
Graph 5.1

This graph shows the development of commodity prices for my two sets of on-index and off-index commodities. All commodity prices have been indexed to 100 in 1985 and then averaged across each of the two sets.



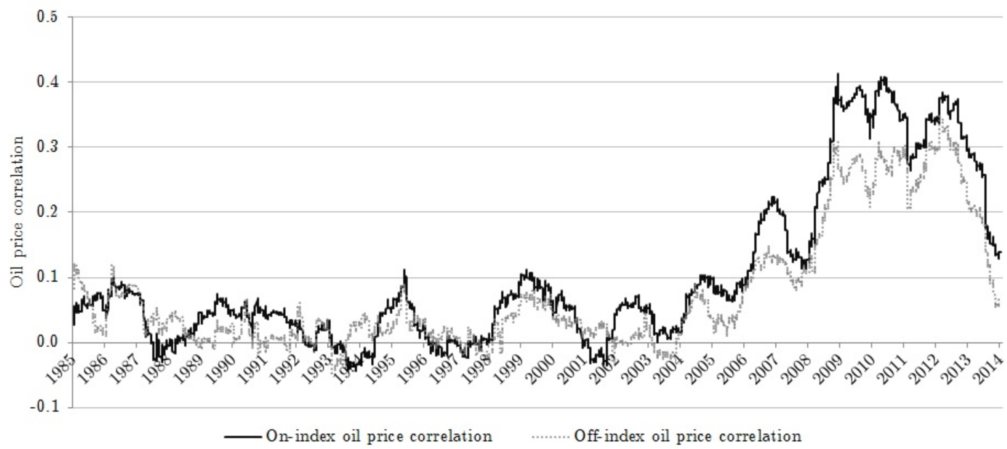
Graph 5.2

This graph shows the average 1-year rolling standard deviation of my two sets of on-index and off-index commodities. Standard deviation was calculated for each individual commodity on a daily basis and then averaged across each of the two sets.



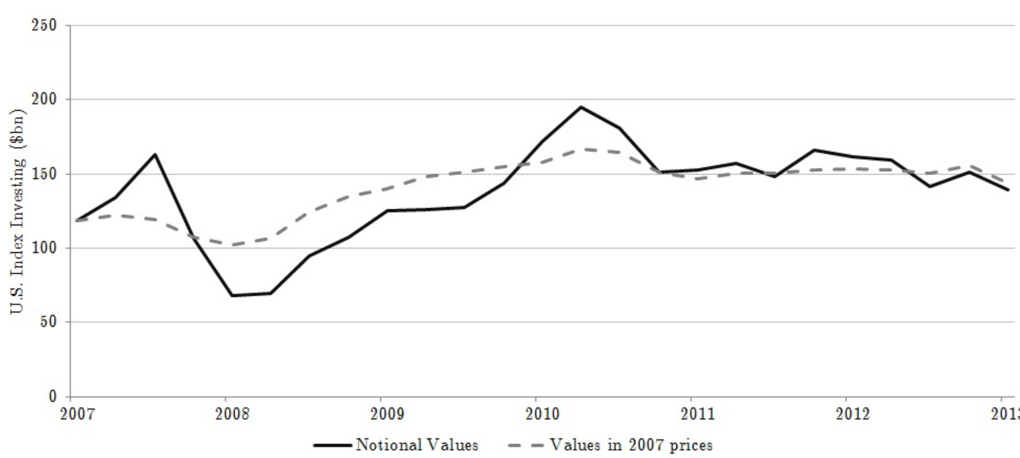
Graph 5.3

This graph shows the average 1-year rolling oil price correlation for my two sets of on-index and off-index commodities. Contrary to my regression methodology, returns have been normalized on a 1-year rolling basis as opposed to a sample wide basis.



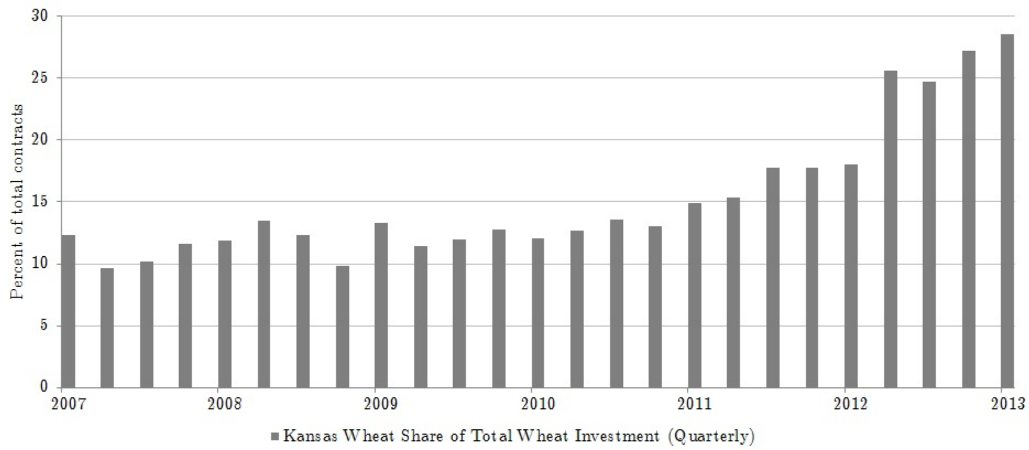
Graph 5.4

This graph shows the total value of U.S. index investing into 21 commodities as reported by the CFTC. The black line shows notional values while the dashed grey line shows values in fixed 2007-level prices.



Graph 5.5

This graph shows the level of index investment into Kansas wheat as a share of total index investment into wheat (either Kansas or Chicago), as reported by the CFTC on a quarterly basis.



Graph 5.6

This graph shows the share of total Energy sector index investment into WTI crude oil and Henry Hub natural gas, as reported by the CFTC on a quarterly basis.

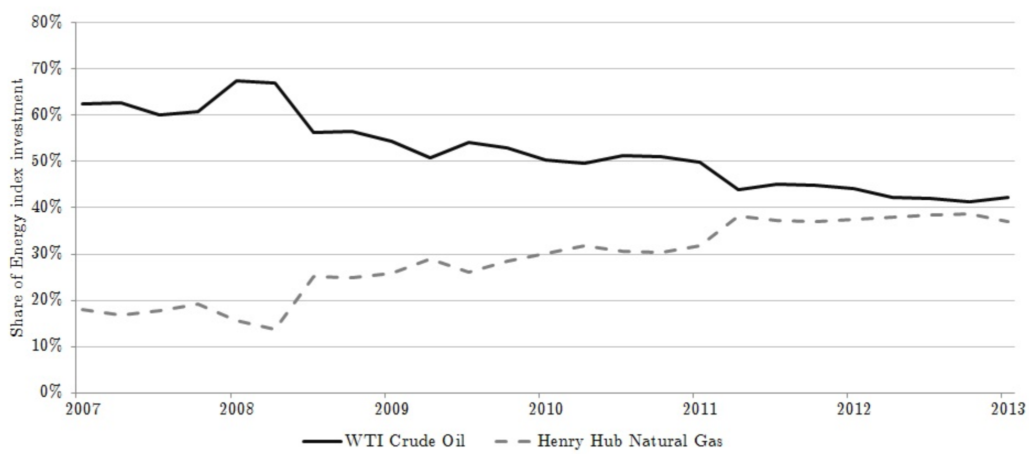


Table 5.1

This table reports the results of regressions I, II and III. In all three regressions, a pooled set of normalized commodity returns have been regressed onto normalized oil price returns. All returns have been normalized by sample mean and standard deviation. Standard errors have been adjusted for heteroskedasticity.

Regression I:

$$\begin{aligned}
R^n_{i,t} = \alpha + [\beta_0 &+ \beta_1 I_{2008} + \beta_2 I_{2008} I_{index} \\
&+ \beta_3 I_{2009} + \beta_4 I_{2009} I_{index} \\
&+ \beta_5 I_{2010} + \beta_6 I_{2010} I_{index} \\
&+ \beta_7 I_{2011} + \beta_8 I_{2011} I_{index} \\
&+ \beta_9 I_{2012} + \beta_{10} I_{2012} I_{index} \\
&+ \beta_{11} I_{2013} + \beta_{12} I_{2013} I_{index}] R^n_{oil,t}
\end{aligned}$$

Regression II:

$$R^n_{i,t} = \alpha + [\beta_0 + \beta_1 I_{postLehman} + \beta_2 I_{postLehman} I_{index}] R^n_{oil,t}$$

Regression III:

$$\begin{aligned}
R^n_{i,t} = \alpha + [\beta_0 &+ \beta_1 I_{post2003} + \beta_2 I_{post2003} I_{index} \\
&+ \beta_3 I_{postLehman} + \beta_4 I_{postLehman} I_{index}] R^n_{oil,t}
\end{aligned}$$

A: Regression I	Coefficient	t-stat	95% Conf.	Interval
Correlation to oil price for all commodities				
Base Correlation	0.0579	15.22	0.0505	0.0654
Additional Correlation by Year				
2008	0.2022	16.19	0.1777	0.2267
2009	0.1251	8.85	0.0974	0.1528
2010	0.3966	14.39	0.3426	0.4506
2011	0.2844	12.53	0.2399	0.3288
2012	0.2527	8.33	0.1932	0.3122
2013	0.0889	2.07	0.0047	0.1731
Incremental correlation for on-index commodities				
Incremental correlation by year				
2008	0.0794	5.29	0.0500	0.1088
2009	0.1189	6.93	0.0853	0.1525
2010	0.0365	1.07	-0.0306	0.1036
2011	0.0728	2.63	0.0186	0.1270
2012	0.0443	1.19	-0.0287	0.1173
2013	0.0486	0.92	-0.0552	0.1523

B: Regression II	Coefficient	t-stat	95% Conf.	Interval
Base correlation	0.0782	19.99	0.0705	0.0859
Post Lehman	0.1681	14.32	0.1451	0.1911
Post Lehman, on-index	0.0922	6.47	0.0643	0.1202

C: Regression III	Coefficient	t-stat	95% Conf.	Interval
Base correlation	0.0281	6.36	0.0194	0.0367
Post 2003	0.1190	9.65	0.0948	0.1432
Post 2003, on-index	0.0515	3.39	0.0217	0.0812
Post Lehman	0.2182	18.3	0.1948	0.2416
Post Lehman, on-index	0.0922	6.47	0.0643	0.1202

Table 5.2

This table reports the results of regression IV. A pooled set of normalized commodity returns have been regressed onto normalized oil price returns and normalized returns of the MSCI Emerging Market index. All returns have been normalized by their sample mean and standard deviation. Standard errors have been adjusted for heteroskedasticity.

$$
\begin{aligned}
R^n_{i,t} = \alpha + [\beta_0 &+ \beta_1 I_{2008} + \beta_2 I_{2008} I_{index} \\
&+ \beta_3 I_{2009} + \beta_4 I_{2009} I_{index} \\
&+ \beta_5 I_{2010} + \beta_6 I_{2010} I_{index} \\
&+ \beta_7 I_{2011} + \beta_8 I_{2011} I_{index} \\
&+ \beta_9 I_{2012} + \beta_{10} I_{2012} I_{index} \\
&+ \beta_{11} I_{2013} + \beta_{12} I_{2013} I_{index}] R^n_{oil,t} \\
+[\gamma_0 &+ \gamma_1 I_{2008} + \gamma_2 I_{2008} I_{index} \\
&+ \gamma_3 I_{2009} + \gamma_4 I_{2009} I_{index} \\
&+ \gamma_5 I_{2010} + \gamma_6 I_{2010} I_{index} \\
&+ \gamma_7 I_{2011} + \gamma_8 I_{2011} I_{index} \\
&+ \gamma_9 I_{2012} + \gamma_{10} I_{2012} I_{index} \\
&+ \gamma_{11} I_{2013} + \gamma_{12} I_{2013} I_{index}] R^n_{MSCIEM,t}
\end{aligned}
$$

D: Regression IV	Coefficient	t-stat	95% Conf.	Interval
Correlation to oil price for all commodities				
Base Correlation	0.0579	15.22	0.0505	0.0654
Additional Correlation by Year				
2008	0.1277	6.92	0.0915	0.1638
2009	0.0274	1.41	-0.0107	0.0656
2010	0.1873	4.92	0.1126	0.2620
2011	0.1387	4.36	0.0764	0.2010
2012	0.1107	3.47	0.0482	0.1732
2013	0.0501	1.33	-0.0237	0.1240
Incremental correlation to oil price for on-index commodities				
Incremental correlation by year				
2008	0.0751	3.15	0.0283	0.1220
2009	0.1211	4.83	0.0719	0.1704
2010	0.0669	1.43	-0.0245	0.1582
2011	0.0750	1.91	-0.0019	0.1518
2012	0.0344	0.90	-0.0404	0.1091
2013	0.0429	0.88	-0.0525	0.1384
Correlation to MSCIEM for all commodities				
Base Correlation	0.0908	22.03	0.0827	0.0989
Additional Correlation by Year				
2008	0.0640	3.97	0.0324	0.0956
2009	0.1295	6.22	0.0887	0.1703
2010	0.1621	5.10	0.0998	0.2243
2011	0.1438	6.05	0.0972	0.1904
2012	0.1757	6.21	0.1202	0.2312
2013	0.0428	1.51	-0.0127	0.0982
Incremental correlation to MSCIEM for on-index commodities				
Incremental correlation by year				
2008	0.0088	0.41	-0.0329	0.0505
2009	-0.0053	-0.20	-0.0572	0.0466
2010	-0.0383	-1.01	-0.1130	0.0363
2011	-0.0039	-0.13	-0.0643	0.0566
2012	0.0213	0.60	-0.0482	0.0907
2013	0.0547	1.55	-0.0146	0.1241

Table 5.3

This table reports the results of regression V. A pooled set of normalized commodity returns have been regressed onto normalized oil price returns and normalized returns of the S&P 500 index. All returns have been normalized by their sample mean and standard deviation. Standard errors have been adjusted for heteroskedasticity.

$$
\begin{aligned}
R^n_{i,t} = \alpha + [\beta_0 &+ \beta_1 I_{2008} + \beta_2 I_{2008} I_{index} \\
&+ \beta_3 I_{2009} + \beta_4 I_{2009} I_{index} \\
&+ \beta_5 I_{2010} + \beta_6 I_{2010} I_{index} \\
&+ \beta_7 I_{2011} + \beta_8 I_{2011} I_{index} \\
&+ \beta_9 I_{2012} + \beta_{10} I_{2012} I_{index} \\
&+ \beta_{11} I_{2013} + \beta_{12} I_{2013} I_{index}] R^n_{oil,t} \\
+[\delta_0 &+ \delta_1 I_{2008} + \delta_2 I_{2008} I_{index} \\
&+ \delta_3 I_{2009} + \delta_4 I_{2009} I_{index} \\
&+ \delta_5 I_{2010} + \delta_6 I_{2010} I_{index} \\
&+ \delta_7 I_{2011} + \delta_8 I_{2011} I_{index} \\
&+ \delta_9 I_{2012} + \delta_{10} I_{2012} I_{index} \\
&+ \delta_{11} I_{2013} + \delta_{12} I_{2013} I_{index}] R^n_{S\&P500,t}
\end{aligned}
$$

E: Regression V	Coefficient	t-stat	95% Conf.	Interval
Correlation to oil price for all commodities				
Base Correlation	0.0579	15.22	0.0505	0.0654
Additional Correlation by Year				
2008	0.1923	9.92	0.1543	0.2303
2009	0.0659	3.33	0.0271	0.1047
2010	0.2737	6.60	0.1924	0.3551
2011	0.1947	5.90	0.1300	0.2593
2012	0.1746	4.91	0.1048	0.2444
2013	0.0611	1.58	-0.0146	0.1368
Incremental correlation to oil price for on-index commodities				
Incremental correlation by year				
2008	0.0751	3.05	0.0269	0.1234
2009	0.1121	4.45	0.0627	0.1616
2010	0.0712	1.41	-0.0279	0.1704
2011	0.0823	2.02	0.0024	0.1622
2012	0.0369	0.88	-0.0457	0.1196
2013	0.0422	0.87	-0.0533	0.1377
Correlation to S&P 500 for all commodities				
Base Correlation	0.0430	10.23	0.0348	0.0513
Additional Correlation by Year				
2008	-0.0142	-0.91	-0.0449	0.0165
2009	0.0932	4.46	0.0522	0.1343
2010	0.1090	3.21	0.0424	0.1756
2011	0.1195	4.93	0.0720	0.1670
2012	0.1056	3.13	0.0394	0.1717
2013	0.0242	0.68	-0.0454	0.0938
Incremental correlation to S&P 500 for on-index commodities				
Incremental correlation by year				
2008	0.0130	0.66	-0.0258	0.0519
2009	0.0156	0.60	-0.0353	0.0666
2010	-0.0423	-1.04	-0.1220	0.0373
2011	-0.0173	-0.57	-0.0763	0.0418
2012	0.0141	0.33	-0.0692	0.0975
2013	0.0157	0.35	-0.0716	0.1029

Table 5.4

This table reports the results of regression VI. A pooled set of normalized commodity returns have been regressed onto normalized oil price returns, normalized returns of the MSCI Emerging Market index and normalized returns of the S&P 500 index. All returns have been normalized by their sample mean and standard deviation. Standard errors have been adjusted for heteroskedasticity.

$$
\begin{aligned}
R^n_{i,t} = \alpha + [\beta_0 &+ \beta_1 I_{2008} + \beta_2 I_{2008} I_{index} \\
&+ \beta_3 I_{2009} + \beta_4 I_{2009} I_{index} \\
&+ \beta_5 I_{2010} + \beta_6 I_{2010} I_{index} \\
&+ \beta_7 I_{2011} + \beta_8 I_{2011} I_{index} \\
&+ \beta_9 I_{2012} + \beta_{10} I_{2012} I_{index} \\
&+ \beta_{11} I_{2013} + \beta_{12} I_{2013} I_{index}] R^n_{oil,t} \\
+[\gamma_0 &+ \gamma_1 I_{2008} + \gamma_2 I_{2008} I_{index} \\
&+ \gamma_3 I_{2009} + \gamma_4 I_{2009} I_{index} \\
&+ \gamma_5 I_{2010} + \gamma_6 I_{2010} I_{index} \\
&+ \gamma_7 I_{2011} + \gamma_8 I_{2011} I_{index} \\
&+ \gamma_9 I_{2012} + \gamma_{10} I_{2012} I_{index} \\
&+ \gamma_{11} I_{2013} + \gamma_{12} I_{2013} I_{index}] R^n_{MSCIEM,t} \\
+[\delta_0 &+ \delta_1 I_{2008} + \delta_2 I_{2008} I_{index} \\
&+ \delta_3 I_{2009} + \delta_4 I_{2009} I_{index} \\
&+ \delta_5 I_{2010} + \delta_6 I_{2010} I_{index} \\
&+ \delta_7 I_{2011} + \delta_8 I_{2011} I_{index} \\
&+ \delta_9 I_{2012} + \delta_{10} I_{2012} I_{index} \\
&+ \delta_{11} I_{2013} + \delta_{12} I_{2013} I_{index}] R^n_{S\&P500,t}
\end{aligned}
$$

D: Regression IV	Coefficient	t-stat	95% Conf.	Interval
Correlation to oil price for all commodities				
Base Correlation	0.0516	13.29	0.0440	0.0592
Additional Correlation by Year				
2008	0.1493	8.07	0.1130	0.1855
2009	0.0327	1.64	-0.0063	0.0717
2010	0.1795	4.05	0.0927	0.2664
2011	0.1414	4.17	0.0749	0.2079
2012	0.1313	3.68	0.0614	0.2012
2013	0.0754	1.96	0.0000	0.1508
Incremental correlation to oil price for on-index commodities				
Incremental correlation by year				
2008	0.0739	3.06	0.0266	0.1212
2009	0.1159	4.50	0.0655	0.1664
2010	0.0874	1.63	-0.0179	0.1928
2011	0.0809	1.93	-0.0011	0.1628
2012	0.0324	0.76	-0.0507	0.1155
2013	0.0475	0.98	-0.0475	0.1426
Correlation to MSCIEM for all commodities				
Base Correlation	0.0982	20.73	0.0889	0.1075
Additional Correlation by Year				
2008	0.0431	2.19	0.0045	0.0818
2009	0.0705	2.97	0.0240	0.1170
2010	0.0956	2.94	0.0319	0.1593
2011	0.0682	2.77	0.0199	0.1165
2012	0.1203	3.98	0.0611	0.1795
2013	-0.0164	-0.56	-0.0739	0.0412

Continued on page 50

Continued from page 49

D: Regression IV	**Coefficient**	**t-stat**	**95% Conf.**	**Interval**
Incremental correlation to MSCIEM for on-index commodities				
Incremental correlation by year				
2008	0.0036	0.14	-0.0455	0.0527
2009	-0.0160	-0.54	-0.0742	0.0422
2010	-0.0290	-0.75	-0.1051	0.0470
2011	0.0039	0.12	-0.0579	0.0658
2012	0.0198	0.53	-0.0538	0.0933
2013	0.0583	1.63	-0.0119	0.1285
Correlation to S&P 500 for all commodities				
Base Correlation	0.0079	1.77	-0.0009	0.0166
Additional Correlation by Year				
2008	-0.0365	-1.97	-0.0728	-0.0002
2009	0.0538	2.32	0.0084	0.0993
2010	0.0876	2.55	0.0202	0.1549
2011	0.0930	3.77	0.0446	0.1413
2012	0.0409	1.16	-0.0280	0.1098
2013	0.0201	0.56	-0.0501	0.0904
Incremental correlation to S&P 500 for on-index commodities				
Incremental correlation by year				
2008	0.0116	0.51	-0.0328	0.0560
2009	0.0227	0.79	-0.0336	0.0790
2010	-0.0344	-0.83	-0.1155	0.0466
2011	-0.0187	-0.61	-0.0785	0.0410
2012	0.0051	0.12	-0.0818	0.0920
2013	-0.0123	-0.28	-0.0981	0.0736

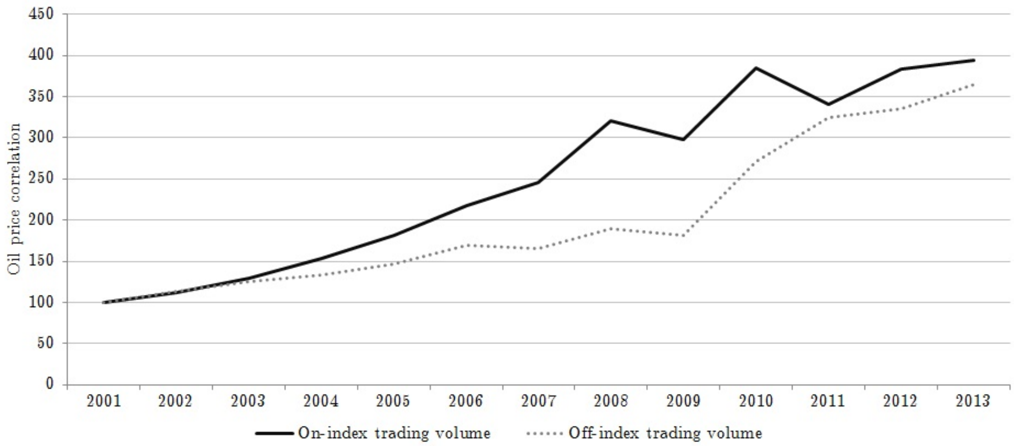
Table 5.5

This table reports the results of the three t-tests discussed in section 5.7. All three tests have the same H_0 hypothesis that indexed trading volumes for on-index commodities are equal to indexed trading volumes for off-index commodities. Panel G reports the test for the period 2001 through 2013. Panel H reports the test for the period 2004 through 2009. Panel I reports the test for the period 2010 through 2013.

G: T-test 2001-2013	**Obs.**	**Mean**	**Std. Dev.**	**95% Conf.**	**Interval**
H_0 : On-index volumes = Off-index volumes					
On-indexed volumes	156	227.24	106.70	210.37	244.12
Off-index volumes	156	208.51	97.81	193.04	223.97
Combined	312	217.87	102.62	206.44	229.30
Diff. (on-index - off-index)		18.74		-4.07	41.54
T-stat					1.62
Degrees of freedom					310
P-value (H_a : Diff. $\neq 0$)					0.1069
H: T-test 2004-2009	**Obs.**	**Mean**	**Std. Dev.**	**95% Conf.**	**Interval**
H_0 : On-index volumes = Off-index volumes					
On-indexed volumes	73	212.32	62.33	197.77	226.86
Off-index volumes	73	168.45	36.24	159.99	176.90
Combined	146	190.38	55.37	181.33	199.44
Diff. (on-index - off-index)		43.87		27.19	60.55
T-stat					5.20
Degrees of freedom					144
P-value (H_a : Diff. $\neq 0$)					0.0000
I: T-test 2010-2013	**Obs.**	**Mean**	**Std. Dev.**	**95% Conf.**	**Interval**
H_0 : On-index volumes = Off-index volumes					
On-indexed volumes	47	352.54	56.21	336.03	369.04
Off-index volumes	47	335.63	73.34	314.10	357.17
Combined	94	344.09	65.54	330.66	357.51
Diff. (on-index - off-index)		16.90		-9.87	43.67
T-stat					1.25
Degrees of freedom					92
P-value (H_a : Diff. $\neq 0$)					0.2130

Graph 5.7

This graph shows the development of trading volumes for my two sets of on-index and off-index commodities. Daily commodity trading volumes have been summed by year, indexed to 100 in 2001 and then averaged across each of the two sets.



Graph 5.8

This graph shows the indexed returns of the S&P GSCI and DJ-UBSCI indices, with values indexed to 100 in 1991. The index values are of total return type, meaning that they include gains or losses resulting from the rolling of commodity futures contracts.