The impact of excessive speculation on commodity market prices

A Master's Thesis
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Acknowledgements and Foreword

This thesis was inspired by my real-world experience of the difficulties of trading commodities where supply and demand are only partially reflected in prices. Many within industry blame this on financial speculation, so it was to that end that I wished to investigate the role of finance in setting commodities prices. This thesis did not simply improve my knowledge of a discipline (financial economics) which is increasingly important in today's world, it also taught me a lot about regulatory decision-making and econometric techniques for testing the hypotheses outlined in conventional economics. For that I am grateful to the flexibility shown by the Faculty of Geosciences at Utrecht University for allowing me to study a subject which is not obviously related to the Sustainable Development master's programme.

I am eternally grateful to both my parents, Peter and Gill, without whose support under trying circumstances none of this would have been possible. I would also like to thank my supervisor Ernst Worrell for his enthusiasm about this topic, Professor Christopher Gilbert of the University of Treno for providing me with data and advice, as well as Sascha Otto for taking the time to answer my questions. Finally, I'd like to thank all of those I have met in Utrecht who have helped me during the writing of this thesis and from whom I have learnt so much during my two years studying here.

Abstract

Following severe price hikes in commodities prices during both 2007/08 and 2011, questions are being asked as to the role of excessive speculation on commodities markets in bringing about this unsustainable situation. Tracking the increased financialisation of commodities markets and the legislatory loopholes which have helped to enable the rise of Over-the-Counter derivatives swaps and other forms of potentially manipulative vehicles, this thesis uses economic theory and econometric tests to ascertain the impact of speculation on commodities prices.

T-tests were used to identify sub-martingale or bubble-like behaviour on daily and monthly LME (London Metal Exchange) Grade-A Copper spot closing prices, and financial bubbles were discovered between October 2005 and May 2006, when prices went from US$4000/ton to US$8700/ton. Further, smaller bubbles were shown in 1987, 1995, 2004, 2008 and 2011.

Granger-causality tests were also used to search for statistical causation between fluctuations in LME spots and 3-month futures returns, with inconclusive results, and between the FTSE100 index and copper returns. It was found that the FTSE100 exhibited strong statistical causation effects on both LME copper spots and 3-month futures returns, with the period mid-2007 to third quarter 2010 showing exceptional cointegration and Granger-causation between the two, theoretically unlinked markets, during times of great financial stress, as exhibited in volatility. In conclusion, financial speculation is shown to have influenced copper price fluctuations as well as possibly causing an unprecedented doubling of market prices in just 6 month.

Contents

1. Introduction

Commodities, being a class of basic goods (metals, fuels and food products) for which there is a demand and which exhibit various levels of fungibility (Marx 1859), help fulfil the most basic of human needs, from food to construction materials and fuel for transport. *Sustainable Development*, being "development that meets the needs of the present without compromising the ability of future generations to meet their own needs," (World Commission on Environment and Development 1987) is often seen as an environmental science, but unless the economics are equally sustainable, environmental sustainability will remain a dream. For the majority of the world's population, the most visible incarnation of economics is through the prices they pay for basic commodities such as bread or rice. It is therefore vital that these prices accurately reflect the reality of supply and demand, that the prices are largely predictable and that they are kept affordable.

What is more, a number of interested parties; producers, suppliers and processors, as well as end users of commodities, all require price predictability of their basic materials in order to provide accurate costings for construction or other projects. For example, the construction of one wind turbine uses hundreds of tons of steel and around half a ton of copper (Vestas 2006; CDA 2012a). If the prices of these commodities rise suddenly, it becomes much more expensive to complete the project and may therefore result in delays or cancellation.

The period 2007-mid 2008 saw unprecedented, across-the-board increases in commodities prices, before the market collapsed and prices plummeted. Similarly, the period from mid-2010 to 2011 has seen a repeat of these price hikes, making long-term planning very difficult. The rapid increase in rice prices during that period, for example, was a major cause in the increase of hungry people in the world to over 1 billion. High food prices have been shown to be the precipitating condition for the civil unrest which swept across Africa and the Middle East, culminating in the Arab Spring (Lagi et al. 2011). *Figure 1* shows the UN Food and Agriculture Organisation's Food Price Index (in blue). Superimposed onto the graph are red lines indicating the start date of food riots in various countries. Although in 2009 prices fell again rapidly, a similar reduction has not been seen in the prices following 2011's peak, meaning global food prices remain at historically unprecedented levels.

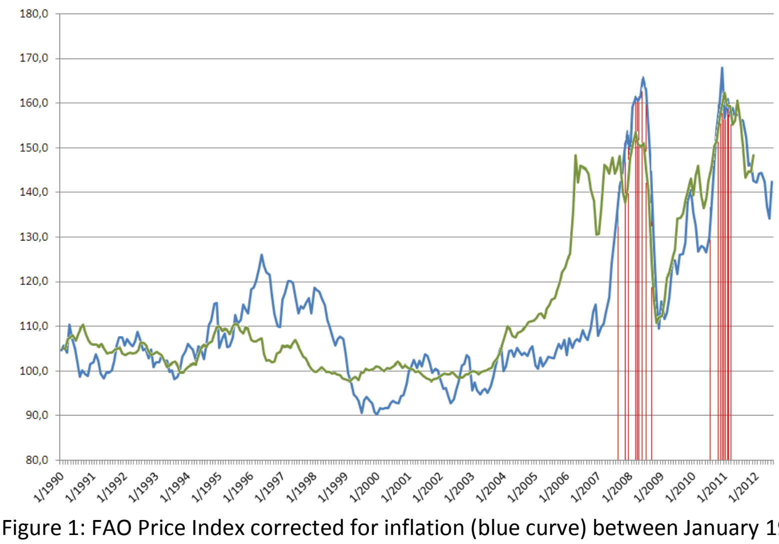


Figure 1: FAO Price Index corrected for inflation (blue curve) between January 1990 and July 2012. Red lines signify start dates of food riots, mainly in North Africa and the Middle East (taken from Lagi et al. 2011). Green line is the normalised LME Grade A copper price (data from IMF 2012)

The causes of these price fluctuations are manifold, and a plethora of explanations have been given for the most recent (2011) fluctuations in food prices, although the price boom also affected other commodities (see *Figure 1*). They include "(a) weather, particularly droughts in Australia, (b) increasing demand for meat in the developing world, especially in China and India, (c) biofuels, especially corn ethanol in the US and biodiesel in Europe, (d) speculation by investors seeking financial gain on the commodities markets, (e) currency exchange rates, and (f) linkage between oil and food prices." (Lagi et al. 2011). Various studies have shown that these many of issues, especially items b and c, could not have caused sufficient global supply constraints across commodity classes to have resulted in such large price increases.

However, it was not simply global food prices which have seen remarkable and highly correlated peaks and troughs starting in the second half of the 00's. The green line on the graph indicates the (normalised) monthly price of grade-A copper traded on the global price-setting London Metals Exchange. Both the rises and falls of the price are highly correlated. The standard explanation for these price fluctuations rest on supply and demand, and take into account variations such as detailed above, only some of which applies to both copper and food commodities. In the general discussion of the reasons behind these price rises, however, financial speculation is often excluded or minimised. This thesis, therefore, will explore the effects of financial speculation on commodity market prices, with tests performed on copper traded on the London Metal Exchange.

1.1 Problem Definition

Commodities exchanges, being primary vehicles for price setting of globally-traded commodities (Pirrong 1994), therefore need to be investigated to discover to what extent excessive speculation is responsible for these fluctuations. As stated by the US Senate Permanent Subcommittee on Investigations "The purpose of commodity markets, unlike stock markets, is not to attract investors, but to enable producers and users of physical commodities to arrive at a reasonable price for their goods and hedge their price risks over time. Prices are intended to reflect supply and demand for the physical commodities being traded. Because those physical goods are used in business on a daily basis, they are vulnerable to price manipulation if someone corners the market on the available supply in a particular month. In addition, speculators, who by definition don't use the commodities they trade and seek instead to profit from the changing prices, can cause distortions in commodity prices when there is excessive speculation." (USSPSI 2011).

1.2 Research Question

To what extent, and in which ways, does excessive financial speculation on commodities influence the market price of globally traded commodities? How can these effects be mitigated in order to achieve a more stable market place conducive to Sustainable Development?

This thesis largely concerns commodities markets in general, while a case study will look specifically at Copper traded on the London Metals Exchange (LME). As such, much of the research present in this master's thesis will be based on existing literature. Because this is a subject about which my knowledge was passive, having never formally studied this discipline before, the sub-questions detailed below have been designed to inform the main research question. Some are based in literature, while one (question 3) also involves the application of econometric tests on the case study. The first three sub questions and the first part of the main research question are answered in the Conclusions (Section 8), while the last sub question, leading to the second part of the main question, is covered in the Recommendations (Section 9). The sub questions are as follows:

1. How have financial and commodities markets developed over recent decades and can this be said to have had an influence on the price-setting function of such markets?
2. What policy options have been proposed and enacted by the European Union and the US Federal government, how can/do they influence commodity markets and what barriers do they face in implementation?
3. How has commodities market behaviour been modelled mathematically, using econometrics, and how can this be used to provide quantitative analysis of the speculative effects on LME copper?
4. What recommendations can be made to improve the price discovery function of commodities markets, and hence produce a more sustainable market for basic commodities?

1.3 Motivation

Studying the Energy and Resources track of the Sustainable Development master's programme at the University of Utrecht has reiterated to me the importance of commodities to sustainable development. While the track is heavily based on energy resources, it has become obvious that accurate pricing of other commodities is vital. Much work is being performed on pricing structures for goods which take into account what economists call the 'externalities', such as pollution and loss of biodiversity caused in extraction and production, as well as health risks and labour conditions for local employees[1]. To this cause an entire course of the Sustainable Development master's at Utrecht University (Trans-disciplinary Case Study, group P7) was dedicated. However, should a system be devised to include the costs of externalities into pricing structures, it would still be highly dependent upon a fundamental supply and demand basis. If financial speculation can be shown to cause major deviations from the 'fundamental price' of a commodity, it would invalidate much of this work.

Added to this, there has been some recognition of the importance of correct pricing of commodities on the international stage. The Global Initiative on Commodities was launched in May 2007 by a group of organisations including the United Nations Conference on Trade and Development (UNCTAD), the United Nations Development Programme (UNDP), the African, Caribbean and Pacific Group of States (ACP), and the Common Fund for Commodities (CFC), with the aim of "leveraging the power of commodity production and trade as a positive force for sustainable development across the developing world" (IISD 2009). From the Initiative, two articles in particular are relevant to this master's thesis. Item A1H stipulates that "Initiatives are required that aim at dealing with negative effects of instability of commodity prices and earning from commodity exports," while Item 3D encourages "the establishment of effectively functioning commodity exchanges in developing countries" (UNCTAD 2007). Should instability be shown to be caused by excessive speculation on (or off) commodity exchanges, then a major initiative must be to rein it in. Secondly, if commodity exchanges are to be encouraged around the world, there are some basic tenants which need to be applied, drawing on the long experience of such exchanges in the 'developed world'.

[1] See, for example, the work of the Oiconomy Foundation (http://www.oiconomy.org) which aims to produce a pricing structure for basic goods which takes into account these externalities.

Finally, I am motivated to study this topic through personal experience. Between 2006 and 2008 I was trading recyclable copper (and other ferrous and non-ferrous) scrap from Eastern Europe. Price fluctuations of hundreds of dollars/ton every day made this business all the more difficult because suppliers would hold off from selling until the price rebounded to a certain level. This often resulted in long delays in buying the material, thus preventing the timely recycling of a vital commodity. It also became clear to me that these fluctuations benefitted neither the supplier nor the customer, and that attributing these sudden price changes to supply and demand evidently missed a lot of the story. It is through this thesis, therefore, that I wish to discover which other mechanisms could be setting prices on top of 'fundamentals'.

2. Methodology

While this thesis forms a valid part of the *Sustainable Development* master's Programme, for the reasons stated above, much of its contents is essentially *Financial Economics*, a subject I had only a basic grasp of beforehand. Therefore a thorough literature review was vital. As such, this thesis opens with investigations into commodities markets, their functioning as well as participants and recent trends of specific interest especially towards sub-question 1 (Chapter 3).

To answer sub-question 2 and to inform answers to sub-question 4 (see Section 1.2) a further literature review was conducted concerning regulatory policies; historical, current and proposed (Chapter 4). Meanwhile, Chapters 5 and 6 look at the theoretical framework behind commodities trading and applying a number of econometric tests to multi-level data in order to answer both the first part of the main research question, and the rest of sub-question 3. Sub-question 4, leading to the second part of the main research question, is informed by the entirety of the report.

Data was largely publically available and acquired through sources such as the IMF (2012). Data for daily LME prices, while publically available, is expensive. Therefore it was greatly appreciated that Professor Christopher Gilbert of the University of Treno was able to provide me with daily closing prices going back to the 1970s.

Terminology used throughout this thesis is as presented in economic literature, although all effort has been made to define these terms in everyday English. For definitions of terms the appendix at the end of Irwin & Sanders (2010) provides a thorough glossary.

3. Commodities Markets

3.1 Introduction to Commodities Markets

Producing commodities takes time. Whether it's planting potatoes and waiting months to harvest them, or extracting minerals or fossil fuels and refining them, as well as transporting these goods to market, it usually requires a large initial investment with returns only coming some months later. For centuries producers have sold a percentage of their crop or final product 'forward', meaning they sell that amount at a price agreed today, but for delivery at some pre-defined point in the future. Between today and that future time, the price of the commodity may change either up or down, but for the producer the price is guaranteed. This is called *hedging*. When the product is ready, the remaining harvest is sold at the time for immediate delivery on what is known as the *spot* market.

Oftentimes the customer is not ready to tie-up their own capital in buying 3-months into the future, unless they too are implementing a hedging strategy. Instead, a middle-man called a speculator or investor[2] will normally buy the futures contract from the producer with the aim of trading that contract for a higher value as the time approaches for delivery, often to another speculator. In such a way speculators are said to provide *liquidity* to a market. Sometimes, during periods of *irrational exuberance*, speculators may bid up the price to an extent where the price paid for the commodity no longer reflects the true cost of the product. In this way excessive speculation can cause *financial bubbles*.

To make the trade of futures and spot contracts easier, commodities exchanges began being formed to provide all market participants with accurate price information, clear contract terms and some form of insurance should the counterparty (the other side of the trade) not be able to deliver. The London Metals Exchange, for instance, was founded in 1877 but its roots go all that way back to the 16th century with the opening of London's Royal Exchange (LME.com 2012). The rest of this section will investigate further the workings of commodities markets before going into some of the modern developments seen both on and off the exchanges. As such it will provide a basis for the rest of this master's thesis.

3.1.1 Purpose and functions of commodities markets

Commodities markets, unlike stock or equities markets, exist in order to provide producers and users of physical commodities with publicly-known, uniform prices and contract terms for a given commodity. (Chang 1985; USSPSI 2011). Commodities markets generally consist of two types of contracts; spots and futures. A spot contract "obliges the buyer and the seller to fulfill their commitments immediately" (Otto 2011), whereas futures contracts require both buyer and seller to complete the transaction at a given, future date. (ibid.) That said, only a small amount of futures contracts sold are actually completed. The buyer or seller can *liquidate* the contract before the anticipated date of delivery by selling or buying equivalent contracts of the same commodity, effectively offsetting the original commitment (Johnson 1960). The functioning of such strategies is explained further in section 3.4.2.

A major function of futures markets is to allow for the transfer of risk from the risk averse (such as producers) to the risk tolerant (investors/speculators). Markets actors who wish to hedge against future price fluctuations can 'lock-in' that price in advance of its production or availability, for sale at a later date. (Pirrong 1994). There is no exchange of cash between the

[2] In the literature the terms speculator and investor are fairly interchangeable. The only difference is that *investor* is generally positive while *speculator* is a more negative term.

two market parties at the time in which a futures deal is made; meaning the value of the contract at inception is zero. (Gorton & Rouwenhorst 2005).

According to Pirrong (1994), the other major function of commodities markets is to "transmit valuable information about supply and demand conditions". Market actors with private information will buy or sell depending on that information, and thus the price will be forced towards the correct market level, while newly-available public information will encourage wise investments (Pirrong 1994; UNCTAD 2011). Producers, consumers and those involved in storage will use this information to make decisions on resource allocation and investments. The relationship between spot and futures prices is discussed in some depth in Chapter 5.

3.2 Definition of Market Actors

Definitions of market actors have long been set by the Commodities Futures Trading Commission (CFTC), the US regulator, which collates and provides large amounts of data traditionally based on two categories of traders – commercial and non-commercial (CFTC 2008). Traders, producers or customers dealing directly in the commodity would be described as commercial, whereas those with no direct interest would be non-commercial, although under this classification it has "become customary in the academic literature to view commercials as hedgers and non-commercial as investors" (Gorton, Hayashi & Rouwenhorst 2008). Positions, in regard to stocks, trades and open interest (uncompleted trades), are reported weekly in the *Commitment of Traders* (COT) report, with macro-level data on both categories. However, these classifications were subjected to much criticism, with the CFTC itself noting in 2006 that "… trading practices have evolved to such an extent that, today, a significant proportion of long-side open interest in a number of major physical commodity futures contracts is held by so-called non-traditional hedgers … This has raised questions as to whether COT report can reliably be used to assess overall futures activity …" (CFTC in Gilbert 2010). Therefore, in September 2009 the CFTC changed the categories of reporting traders for their *Disaggregated* Commitment of Traders reports (Büyükşahin & Robe 2010), as shown in *Table 1*.

Category	Description
Producers, merchants, processors, users	Entities which deal predominantly in physical commodities, and which use futures markets to hedge or manage risks associated with their main business
Swap Dealers	Entities which mostly trade in Over-the-Counter swaps (see section 3.6), and use the futures markets to hedge or manage risks associated with that business. The majority of these traders' clients have investments which track commodity indices (see section 3.4.2)
Money Managers	Entities which manage on-exchange futures trading on behalf of their clients. Names of such money managers range from Commodity Trading Advisors (CTAs), registered Commodity Pool Advisors (CPOs), as well as unregistered funds, many Hedge Funds and large Exchange Traded Funds (again refer to section 3.4.2)
Other Reporting Traders	Every other reporting trader who is not included in the above
Non-reporting Traders	Smaller traders who are not obliged to report their positions

Table 1: Categories and description of the five trading classes identified by the CFTC in their *Disaggregated Commitment of Traders* reports (UNCTAD 2011; Tilton, Humphreys & Radetzki 2011)

The first two classifications are considered to be *commercial*, whereas the latter two reporting categories are *non-commercial*. The money manager category includes a spectrum of investors, from hedge funds to institutional investors (largely pension funds and university endowments), who, like many of the swap dealers' clients, have highly diverse investment portfolios and therefore use financial investment strategies (normally reliant on large-scale data analysis) to adjust their exposure to different markets as prices and conditions change (UNCTAD 2011). Although these categories provide more detailed data on traders, there are still some major shortcomings. According to Tilton, Humphreys & Radetzki (2011), “the available data are far from adequate. In particular, little is known about investor demand outside the OECD.” This means that care should still be taken when using these categories.

Other studies have suggested classification based on the type of trade, rather than the identity of the trader, as in reality market actors run trading strategies which are on a continuum between “pure risk avoidance [hedging] and pure speculation” (Irwin, Sanders & Merrin 2009). Nearly all commercial hedgers will also speculate on price movements, while investors will also likely involve some hedging in their market strategy (UNCTAD 2011). Meanwhile, Prof. Bernard Donefer, quoted in Arnuk & Saluzzi (2008), asserts that “The problem is that regulators have been running at their studies on players, for example, broker-dealers, hedge funds, etc. FINRA [the largest independent securities regulator in the U.S.] has no clue as to the kind of trading being done and the strategies behind it. Regulators should require tagging of orders [by algorithms] as opposed to by category of players.” As such, the following sub-sections detail the two principle trading strategies, hedging and speculating, as well as a third important role which market actors play, that of the arbitrageur.

3.2.1 Hedgers

Hedging uses the market as a form of insurance against future price movements. A hedger is traditionally considered a *commercial* market actor, as this strategy is largely (but not exclusively) employed by producers or consumers who wish to secure the market price of a product which will be available at a certain time in the future. A potato farmer, for example, will know that their crop will be ready in 90 days, and will therefore sell a portion of the expected yield on the futures market in order to ensure the future price of that share of the harvest. End users will operate in the same way and buy these futures contracts in order to hedge their own risk – they know what the price will be for a certain amount of potatoes at a given point in the future, regardless of later fluctuations.

In this way, hedging is used to provide a more certain outcome, although not necessarily the one with the highest returns (Hull 1993). Financial hedging is very popular in equities and FX (currency exchange) markets as a way to insure against fluctuations, although as commodities are fundamentally different to these assets due to their physical nature (the expense involved in transport and storage does not exist in other markets) financial hedging does not normally involve buying the physical commodity and selling it in the future. Rather, commodities futures are used, especially by swap dealers, to hedge against other assets which are considered to have a negatively correlated relationship (UNCTAD 2011), such as that proposed by Gorton & Rouwenhorst (2005) and later empirically shown by Büyükşahin & Robe (2010) between equities and commodities, a relationship especially visible in the turbulent market conditions following the fall of Lehman Brothers in 2008. Büyükşahin & Robe (2010) go so far as to blame much of the recent price volatility in commodities on the existence of Hedge Funds which used commodities as a hedging instrument against exposure in the equities market. This is problematic for legislators as these financial hedgers are often considered *commercial* traders, and therefore avoid many of the regulations aimed at non-commercial speculators.

3.2.2 Speculators

While both producers and consumers may wish to hedge their investments by selling/buying futures contracts, they do not usually trade directly with each other, not least because there may be an issue with the liquidity of the consumer in providing enough capital for the trades. Therefore the buyer of futures contracts is normally a speculator looking to take a position on the market (UNCTAD 2011; Hull 1993). In such a way, speculators are said to provide liquidity to futures markets (Friedman 1953). Tilton, Humphreys & Radetzki (2011) split speculators into two categories; long-short and long-only speculators. Long-short speculators are typically leveraged (they use borrowed money) investors who readily buy or sell depending on market conditions, and thus seek to make money out of both positive and negative market fluctuations. They include the trading desks of major banks, Hedge Funds and technical investors who base their strategies on computer simulations of market conditions (see section 3.5.1 for more on algorithmic trading), and as such *follow* the market (Tilton, Humphreys & Radetzki 2011).

Long-only speculators are typified by a fast-growing class of index-related investors (a thorough analysis of this topic is given in Section 3.4.2). They are generally unleveraged (they trade with their own money) and are much less sensitive to price fluctuations than long-short speculators (Tilton, Humphreys & Radetzki 2011). They track a 'basket' of commodities defined in the index, and hold only long positions which they *roll-over* as maturity of the forward contract approaches (again see Section 3.4.2). Both types of speculation in commodities have increased significantly since the 1990s, and both have led to wide-spread accusations of market manipulation (ibid.)

3.2.3 Arbitrageurs

Arbitrage is a hugely important concept in finance. It is the mechanism by which, given certain criteria, prices for the same commodity on geographically separated exchanges will tend to equality. Should the price of wheat, for example, on an exchange in London be significantly cheaper than in Chicago (when also taking into account transaction costs), arbitrageurs will buy in London and sell in Chicago, thus making easy, risk-free profit while increasing demand in one place and boosting supply in the other, and leading to an equalisation in prices (Hull 1993). The theoretical basis of arbitrage is covered further in Section 5.1.2.

It should be reemphasised here that all three of the above roles can be performed by the same market party, making definition by agent a difficult task and lending weight to Professor Donefer's preference for *types of trade* to be monitored by the CFTC, rather than the *identity* of the trader themselves.

3.3 Financialisation

During most of the 20th century, commodities futures were traded on regulated exchanges, where meaningful speculative position limits, restrictions on the amount of stock a single trader is permitted to hold, were in place (Frenk & Staff 2010). In response to the Wall Street crash of 1930, the US Commodity Exchange Act 1936 "prescribed speculative position limits for agricultural commodities in order to prevent commodities futures markets from becoming overly speculative." (Masters & White 2008). Following severe price increases in the mid-1970's, emanating from a variety of factors, possibly including speculation, a number of curbs were proposed, including the federal extension of these limits to all commodities (Irwin, Sanders & Merrin 2009; Masters & White 2008). However, with the growth of financial futures in the 1980s and '90s, and a changed political climate, "the CFTC was devoting most of its time and resources to regulating financial futures and not commodity futures" (Masters & White 2008). Regulators often missed important differences between commodities and other markets (such as equities), and therefore treated them both as financial markets, ignoring the fact that commodities have major underlying properties, like the physical production and required storage, which are not applicable to equities or foreign exchange markets. They also missed the importance of these markets to global price-setting for industry (ibid.). Section 4.1 covers these events in more detail.

The growth of both volume and open interest in commodities trading meant that speculators would need to take larger positions to manipulate the market. Speculative position limits were therefore raised across the board. (Masters & White 2008). By 1991 the CFTC had started to allow exemptions from position limits for certain transactions, so allowing non-commercial actors to take larger and larger positions. In 1998 the CFTC formalised an existing practice by allowing commodities futures exchanges which dealt in 'large and liquid' markets to replace speculative position limits with 'position accountability limits' (ibid.). Rather than providing actual limits to speculative positions, these accountability limits formed a ceiling, above which the exchange was asked to "watch the Speculator's position with greater vigilance in order to prevent manipulation" (ibid.).

Initially, the involvement of financial investors in commodities revolved around hedge funds making short-term investments made using technical analysis (UNCTAD 2009). However, following such events as London's *Big Bang* of 1986, whereby exchanges in the City moved from traditional open outcry to electronic trading, it became easier for new actors to become involved in markets where previously they had had little or no experience. Commodities exchanges were generally slower than other financial exchanges in adopting electronic trading, and the London Metals Exchange (LME) only introduced its electronic trading system, LME Select, in 2001. By 2006, however, LME Select accounted for around half of all trades on the LME (Cox, Lynton & Wells 2007).

Following the dotcom crash of 2000, financial investors started to look more and more at commodities futures in order to diversify their portfolios. Subsequent crashes and diversification led the number of outstanding futures and options contracts on commodity exchanges to increase more than five times between 2002 and mid-2008 (UNCTAD 2009), the total value of investment in commodity indices increased from around $15 billion in 2003 to more than $200 billion by mid-2008 (CFTC, quoted in Tang & Xiong 2011), and the value of Over-the-Counter (OTC) trades in commodity derivatives ballooned more than 20 times, to $13 trillion by the time of the *Credit Crunch* (UNCTAD 2009). Further explanation of these investment mechanisms is given in Section 3.4. Up to around 2005, the prices of most commodities had been largely stable (European Commission, quoted in De Schutter 2010), but after that point two notable things occurred; prices of previously unlinked commodities, such as gold and agricultural commodities, inexplicably started to exhibit similar price movements, while the values of these commodities soared from August 2007, following the sub-prime crash. Oil broke the $100/barrel mark in February 2008, finally peaking in June of that year, before falling back (De Schutter 2010).

While world GDP doubled (in dollar terms) between 1998 and 2008, commodity prices almost quadrupled over the same period (UNCTAD 2009). Indeed, by 2008 the value of outstanding commodity futures contracts (totalling almost $13 trillion) was roughly twice the real global output of commodities (ibid.). For gold, copper and aluminium in 2005, the "volume of exchange-traded derivatives was around 30 times larger than physical production" (Domanski & Heath 2007). To add more perspective, in the ten years to 2008, the ratio of notional commodity futures contracts to global GDP rose from 1.5% to over 21 percent, while equities markets saw the equivalent ratio rise from 4.2% in 1998 to just less than 17 percent (ibid.).

The recent change in the constituency of commodities markets has been substantial. *Figure 2* shows the change in market share of commercial and financial (what the CFTC generally refers to as *non-commercial*) traders on the Chicago Wheat markets between 1996 and 2008. However, this change is not limited to Chicago Wheat contracts. Across the board, aggregate market share of 'traditional commercial' agents has halved since 2000, while the market share of financial traders more than doubled between 2000 and 2008, from less than 20 per cent to over 40% (Büyükşahin et al. 2008). In their 2010 paper, Büyükşahin & Robe documented "considerable increases in the presence of hedge funds [on commodities markets] and in the extent to which equity futures traders are also active in commodity futures markets".

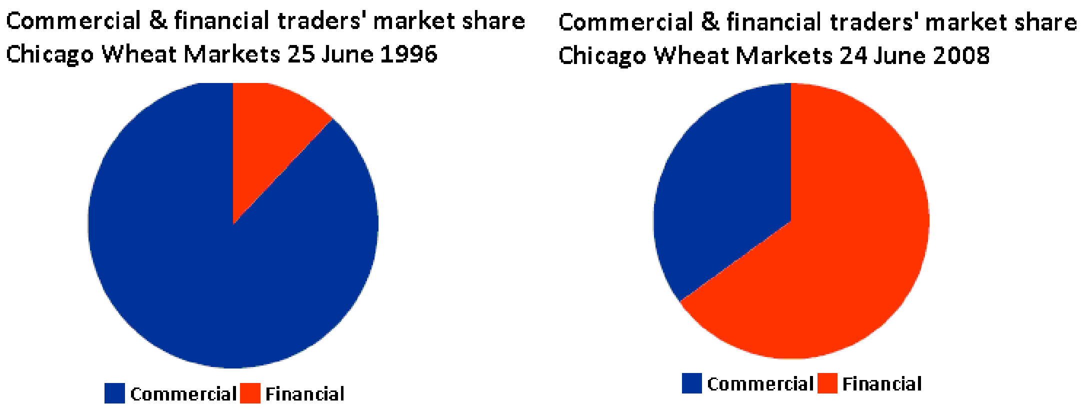


Figure 2: Commercial & financial traders' market share Chicago, comparison 1996 and 2008 (from Ghosh 2011)

Aside from the increased prices and volatility seen recently in commodities markets, a further change in these markets has seen the *co-integration* of price fluctuations both between different, previously un-related commodities and between commodities and other financial markets. In recent years price movements of all commodities have become increasingly linked to oil fluctuations, especially in long-futures contracts of a year or more (Büyükşahin et al. 2008). Tang & Xiong (2011) showed that this co-integration was especially pronounced amongst commodities which are traded as part of an index (see section 3.4.2a), implying that the price of a commodity is no longer determined by supply and demand fundamentals, but rather "prices are … determined by the aggregate risk appetite for financial assets and investment behavior of diversified commodity index investors" (Tang & Xiong 2011). Furthermore, Büyükşahin & Robe (2010) tested for correlations between commodities and equities markets, and found that these co-movements (where decreases in equities lead to increases in commodities prices) are much more significant during times of 'economic stress'. Granger-causality tests detailed in Section 6.6.2 and 6.7.2b investigate these effects with reference to LME Grade-A copper and the FTSE100 financial index. Following the Lehman Brothers' crash of September 2008, the correlation between equity and commodity markets rose to levels unseen for decades, as Basu & Gavin (2011), performing a similar analysis, show in *Figure 3*. Here, the largest commodity index, the S&P-GSCI (see section 3.4.2), as well as the price of West Texas Intermediate crude oil, is compared with the Wilshire 5000 equities index, and the increased correlation post-2008 is striking. Büyükşahin & Robe (2010) attribute this co-integration across financial markets to Hedge Funds, especially those trading across both markets. Hong & Yogo (2010) give another indication of the changed commodities markets by documenting a third form of co-integration, that of the explosion in open-interest (i.e. un-matured, or open, futures contracts) across commodities. Between 2003 and 2008, open interest grew at a higher rate than at any time since the 1970s. Surprisingly, they found that "open-interest growth seems to lead commodity returns" (ibid.). This means that high market activity, shown by the number of open contracts, drives, or at least predicts, subsequent commodity price fluctuations.

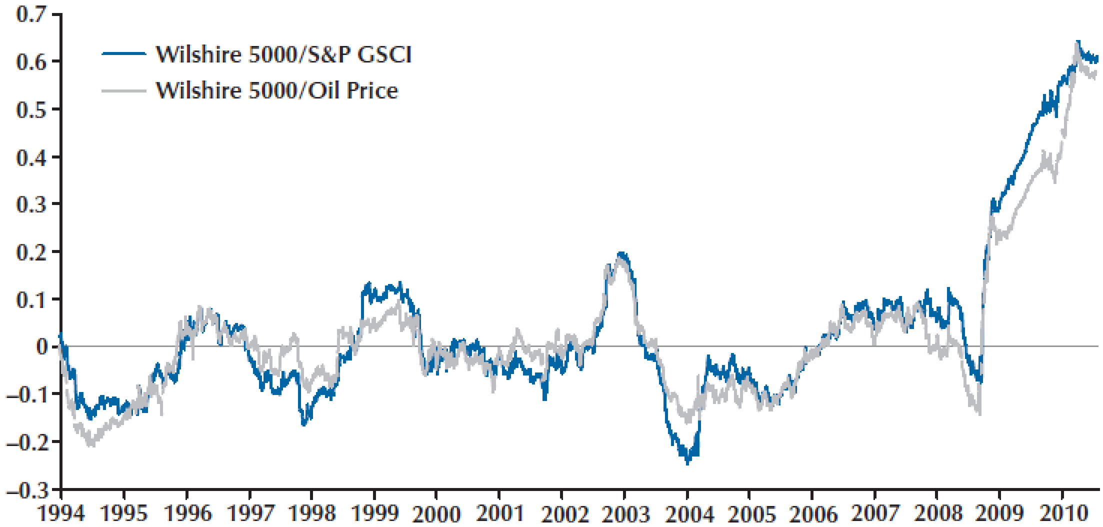


Figure 3: The rolling correlation co-efficient between daily Equity and Commodity returns on a one-year window (from Basu & Gavin 2011)

It should be stressed that co-movements of prices are not new, however. As Tang & Xiong (2011) point out, the last time commodities were highly co-integrated was during the 1970s and early '80s, due to reoccurring oil supply shocks, stagflation and double-digit inflation in the US. This time, however, none of these symptoms are visible and the co-movements amongst commodities are rather more pronounced, implying a significant difference between the late 2000s and the late 1970s.

The underlying causes of the *financialisation* of commodity derivatives are manifold, although Basu and Gavin (2011) give two primary reasons for it. Firstly, they point out that, as returns on equity markets shrank, investors were drawn towards commodities derivatives because of a "mistaken notion that an investment in commodity futures can be used to hedge equity risk". Irwin & Sanders (2010) add that a number of influential papers (including Gorton & Rouwenhorst 2005) have recently fed this 'mistaken notion' by suggesting investors can maximise their returns and lower their portfolio risk by a "relatively modest investment in long-only commodity index funds". Secondly, Basu and Gavin (2011), involve the idea of 'search for yield', whereby low interest rates on low risk investments drive investors to search for riskier deals with a higher rate of return. When a large number of market actors are looking for the same higher yields, however, it bids up the price of riskier assets and thus effectively reduces the price of risk, leading to further investment in an upward spiral.

With these changes in commodities markets, commodity trading has become controversial. Many analysts, market traders and academics argue that changes in the identity of traders, combined with increased investment, have had a substantial impact on real-world prices, have increased uncertainty and therefore increased the risk undertaken by 'traditional' commodity market actors in making storage, investment and trading decisions (UNCTAD 2011). Büyükşahin & Robe (2010) continue that increased financialisation of commodities markets has increased their susceptibility to "financial market sentiment", either by *en-mass* movements in or out of risky markets, or simply because gloomy traders may be less willing to take risks, thus compromising market arbitrage. However, there are many economists and institutions, including the IMF, who continue to assert that ''there remains little evidence that financial investment has a significant sustained impact on commodity prices above and beyond current and expected supply-demand fundamentals'' (IMF 2010, quoted in Tilton, Humphreys & Radetzki 2011)

3.3.1 Motivation for financialisation

While some of the reasons for financialisation are discussed in the preceding section, the motivation behind the willingness of non-market participants, such as governments, regulators and the exchanges themselves, to permit or promote this idea is another matter for contemplation.

Modern financial exchanges are publicly-traded, for-profit corporations who are obliged to maximise returns to their shareholders. As they are paid based on the number of trades made on the exchange, they obviously aim for the highest number of trades possible. Due to deregulation of financial markets, commodities exchanges are no longer required to enforce position limits, so the more (high volume) speculators in the market, the better for the exchange (Masters & White 2008). The LME makes an interesting case-study as the largest shareholders also get privileged market access, forming the so-called *ring* traders. As the majority of these ring members are now banks and other financial institutions, financialisation and de-regulation has meant they can take ever larger positions in commodities in order to maximise returns – JP Morgan's 2010 purchase of up to 90% of LME copper stocks is just such an example, and is elaborated upon in Section 3.4.1, while the LME is described in more detail in Section 6.3.2.

The motivation behind governments' and regulators' acceptance of financialisation is much more complicated. Gensler (2010) gives a number of reasons for deregulation of commodities markets in the lead-up to financialisation. Firstly it was claimed that commodity derivatives, being an 'institutional marketplace' did not need to adhere to the same protections as the general public, not least because those institutions trading there were already regulated (to some extent). Also, as derivatives traders were seen as experts, it was assumed that they could regulate themselves, or that by acting in their own interest they would in turn promote the general public interest. This seems increasingly perverse when considering the lender of last resort to the 'too-big-to-fail' institutions turned out to be the general public themselves. The argument was also made that OTC derivatives swaps (see Section 3.6) could not be bought onto exchanges because they were customised for each individual deal, unlike on exchanges where contract terms are uniform. Since the turn of the millennium, however, these swaps have become increasingly uniform themselves, and many would not look out of place on an exchange. Lastly, as no one else in the world was regulating their markets, legislators did not want to create regulatory arbitrage by regulating trades which no one else was. In summary, by considering financial markets to be inherently efficient, and regarding commodities as just another asset class, governments have been dissuaded from regulating these markets and, in so doing, have given the green light to the increased financialisation which has been evident in the past decade (see Section 5.3). Whether the current crisis will make a serious impact on these beliefs remains to be seen.

3.4 Speculation

Some speculation in commodity markets is seen as essential. It provides liquidity and enables the risk-adverse to maximise their returns (Working (1960) quoted in Irwin, Sanders & Merrin 2009). Milton Friedman (1953) argued that speculation will stabilise prices, because otherwise investors will lose money and will therefore transfer investments to more profitable areas. Gilbert (2010) contends that this viewpoint, while influential, is not generally seen as convincing. He gives the example of clients in a casino. Although customers regularly lose money, the casinos remain in business. Likewise, as the market is a zero-sum game, some advisors or money managers will give advice which will result in investors losing money. The advisor may go out of business, only to be replaced by other companies. However, as long as commodities exhibit "a sufficiently high excess return and sufficiently low correlations with other asset classes," they will be seen as a good addition to a portfolio which will improve the "overall risk-return characteristics of the portfolio" (Gilbert 2010) and speculation will continue.

Although speculation may be seen as positive, *excessive* speculation, leading to market manipulation, is overwhelmingly condemned (De Schutter 2010). Büyükşahin & Robe (2010) used Working's T-model for detecting excess speculation, and found that between July 2000 and March 2010 "speculative positions [across commodity markets] were on average 11% to 50% greater than what was minimally necessary to meet net hedging needs". What is more, excessively speculative positions increased from around 11% in 2000 to 40-50% in 2008, a phenomenon much more visible in near-term contracts, although one which has also fallen since 2008 (ibid.)

In modern finance theory, a distinction is made between informed and uninformed speculators. Accordingly, informed speculation turns private information into publicly-quoted market prices, thus helping in price discovery. The theory continues that uninformed speculators will have no such effect on the market, as informed traders will take advantage of the situation to return prices to their true level by taking contrary positions (Gilbert 2010). In practice, it is difficult to distinguish between informed and uninformed actors, especially in a market where the composition of traders is fluid, while Gilbert (2010) adds that in volatile markets it is more likely that informed investors will "sit on the sidelines until sense returns to the market since there is no easier way to lose money than to be right but to be right too early".

The following sub-sections will look at forms which this speculation may take, while sections 3.5 and 3.6 will investigate different issues surrounding exchange-traded commodities and off-exchange, or Over-the-Counter, trading.

3.4.1 Dominant position taking and 'cornering the market'

In 2010 alone, there were 617 occasions of a single organisation holding a dominant position across the LME metals markets (Farchy 2011). Although a dominant position is not defined, owning around 50% or more of the market would seem to be a reasonable qualification (Mackrell International 2011). In December 2010, one trader held up to 90% of the LME's aluminium stocks, while the nickel, zinc and aluminium alloy markets saw single traders owning between 50% and 80% of those metals, with one firm holding 40%-50% of the LME's tin stockpiles. A well-publicised case involved one firm in November 2010 (rumoured to be JP Morgan) buying between 50-80% of the 350,000 tonnes of LME Copper stocks. This coincided with spot prices reaching a two-year high of $8,700/tonne on that day. (Armitstead & Mason 2010). By December 2010, one trader (the identity of which is unknown – JP Morgan stated they did not own more than 90% of the market (Taylor & Desai 2010)) owned 80-90% of all LME copper, a position which coincided with a new record price of $9,353.50/tonne on that day (Shumsky & Cui 2010). That said, by late January 2011, when there was no one trader holding more than 30% of LME copper stocks, the price still reached a new record high of $9,800/tonne (Farchy 2011), implying there are more mechanisms at work than simply a single player dominating a market, or that the investor was very clever in selling-off their assets. Many studies, not least by Gorton, Hayashi & Rouwenhorst (2008) have shown that low inventories, which dominant position taking could create, lead to a higher risk of 'stock out' and therefore increased volatility in future spot prices, although

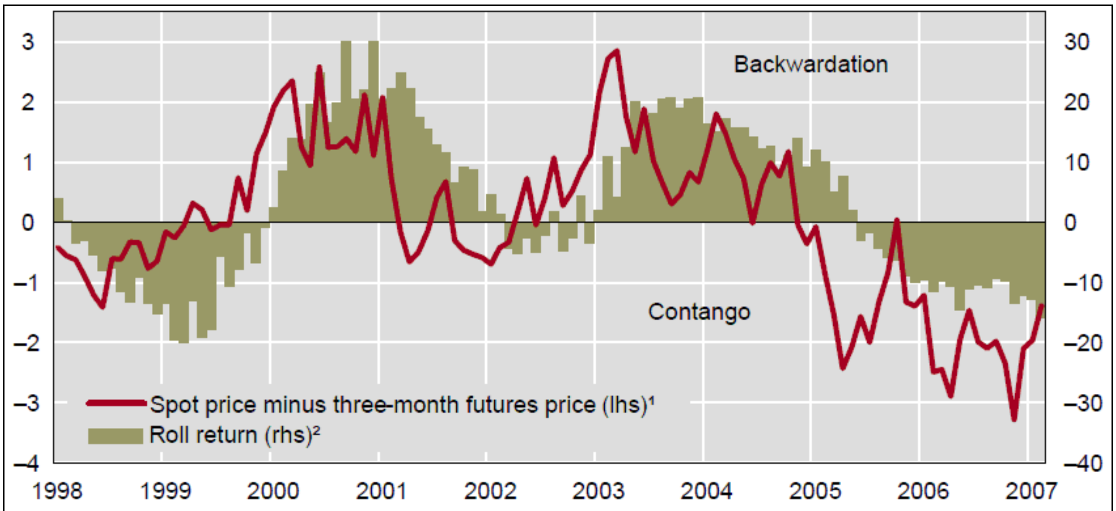
Irwin, Sanders & Merrin (2009) claim that inventories should increase during times of financial bubbles, so low inventories should indicate the *absence* of market manipulation. It is unclear whether they considered dominant position taking in this analysis.

One serious and undisputed case of cornering the market occurred during the 1970s and involved America's [then] richest family, the Hunts. In 1973, as a hedge on their investments in oil, and following the nationalisation of their major oil field in Libya, the Hunt brothers started to buy silver at around $1.50 an ounce (Hernandez 2011). Not only were the brothers trading in silver futures, they were also taking delivery of the metal, so that by mid-1979 they had acquired around 42 million troy ounces (the measurement of silver) – around 10% of global supplies (Williams 1995). The market peaked in January 1980 at a price of $54 an ounce, by which time the Hunt Brothers owned 250 million ounces of the metal, or around half the world's supply (Williams 1995; Hernandez 2011). The brothers did not stop buying at this point, however, rather they continued to order futures contracts (Hernandez 2011). The bubble burst in March 1980, on a day known as 'Silver Thursday' when the brothers ran out of cash to pay for the $135 million of futures obligations, and by the end of the year the price had dropped back to $11 an ounce (Hernandez 2011). The Hunt brothers were bankrupted, suspended from trading and were eventually tried in 1988 in a civil case bought by a Peruvian metals marketing company who had lost heavily in silver in 1979. They were found guilty of "conspiracy, manipulation, monopolisation, racketeering and fraud on the market" (Williams 1995). Such legal actions have been notably missing so far in the post-crash environment, possibly due to the far increased complexity of modern markets and the lack of understanding on the part of regulators and business people alike.

3.4.2 Commodity Indices and Exchange Traded Funds

In 1990 Harry Markowitz, considered the father of 'modern portfolio theory', won the Nobel prize in economics for his 1952 work on producing a "decision-making framework within which investors decide their investment portfolio allocations by considering the expected return and expected risks of all possible combinations of risky assets" (Stoll & Whaley 2009; Nobelprize.org 1990). Initially these portfolio investments took place only in the highly liquid stocks, bonds and currencies markets, but by the turn of the new millennium the costs and difficulties of making 'alternative investments' in markets such as commodities had largely been overcome (Stoll & Whaley 2009), not least through the application of electronic trading on those exchanges. Index investors saw commodities as a chance to diversify their portfolios, somewhat encouraged by an influential 2005 paper by Gorton & Rouwenhorst, which showed that returns from commodities are "inversely correlated with those of equities and stocks and therefore bring greater stability to broader-based portfolios" (Tilton, Humphreys & Radetzki 2011).

Commodity futures are different from other derivatives because on completion of the contract the stipulated quantities must be delivered. This is problematic for commodity indices which should always retain a specific portfolio of commodities. The issue is overcome by 'rolling' the commodity, which involves replacing a contract which is close to maturity with a following, equivalent contract, thus providing returns comparable with taking 'passive long positions' (Domanski & Heath 2007; Tang & Xiong 2011). Investors will earn positive 'roll returns' if the price of the new contract is lower than the spot price of the commodity at that time (Domanski & Heath 2007) i.e. if the market is *backward-ated* (refer to Section 5.1.1 for explanation). Under a backward-ated market, roll-returns can be considerable (ibid.). *Figure 4* shows roll returns on oil in the 9-year period leading up to 2007, where the green blocks are the roll returns and the red line the spot price minus the three-month futures price. During 2003-04 the roll yield from three-month futures was 14% per annum, although as market conditions changed around 2005, these profits became losses under the new *contango* market regime (again, refer to Section 5.1.1 for explanation). Domanski & Heath (2007) blame this change in the market on the increased presence of investors with short time horizons, such as Hedge Funds, which saw a three-fold increase in market participation between 2004-2007. Interestingly, this market *contango* has actually led to significantly decreased profits in index trading, with Standard & Poors claiming a reduction from 2009's forecast returns of 65% to a *mere* actual 12.8% return on investment (Cui 2010).



[1] In US dollars per barrel. [2] Annual returns from rolling over consecutive three-month futures at maturity in excess of spot price returns.

Figure 4: Crude Oil Price and Roll Returns (from Domanski & Heath 2007; Sources: Bloomberg and BIS)

Domanski & Heath (2007) detail some of the appealing aspects of commodity index trading to institutional investors, such as pension funds, which necessarily employ a long-term investment strategy. Firstly, commodity index funds (CIFs) are a reasonably cheap way to diversify portfolios with assets that "have had a relatively low correlation with prices in other asset classes and a high correlation with inflation" (ibid.). Secondly, they find evidence that returns on long commodity futures are comparable to returns from other asset classes such as equities, and therefore a reasonable investment.

Commodity index products are very diverse, and include managed funds, Exchange-Traded Funds (ETFs) and Exchange-Traded Notes (ETNs), and Over-the-Counter return swaps (refer to section 3.6 for details) (Stoll & Whaley 2009). *Figure 5* shows a schematic of these vehicles for commodity index investment. Both ETFs and ETNs are traded on exchanges like stocks and shares, but in reality ETFs are essentially mutual funds with a corresponding share price which tracks an index, while ETNs are actually debt securities, where the issuer pays a sum dependent upon the underlying index (Irwin & Sanders 2011). As Armitstead & Mason (2010) point out however, because ETFs are backed by physical stocks, rather than the paper assets of futures contracts, they could have a different effect on spot prices than normal futures or index investments, which generally make long-only investments, are unleveraged and significantly less price-sensitive than traditional long-short speculators, making them fundamentally passive investors (Tilton, Humphreys & Radetzki 2011; Stoll & Whaley 2009). Indeed, it has been postulated that the dominant position taken by JP Morgan in copper (Section 3.4.1) was caused by the investment bank "positioning themselves in front of [i.e. before the release of] the ETF" (Armitstead & Mason 2010).

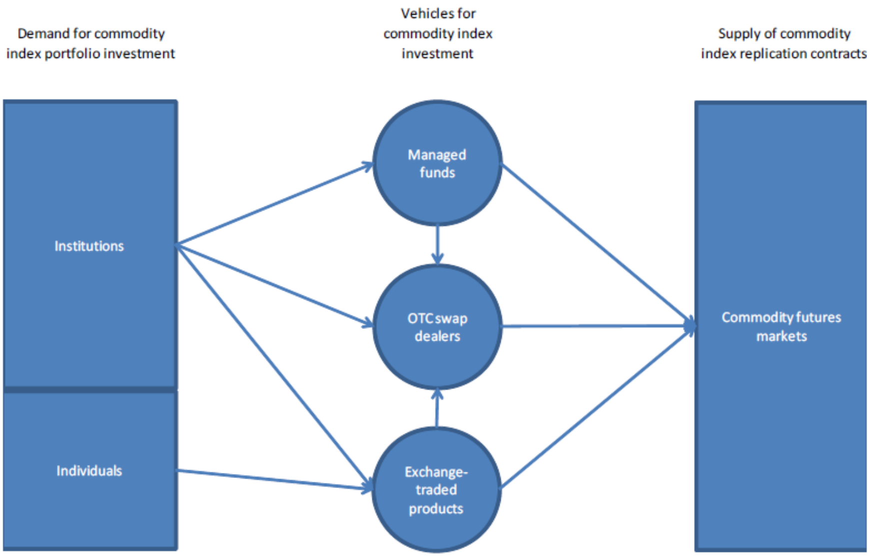


Figure 5: Schematic of the relation between the supply of commodity index-based investment, the demand for these portfolio products and some of the available vehicles for this investment (from Stoll & Whaley 2009)

While the overall level of CIF investment remains unclear, the CFTC, quoted in Tilton, Humphreys & Radetzki (2011) estimates that investment increased from less than $10 billion in 2002 to $211 billion by November 2010. Using data from Barclays, Irwin & Sanders (2010) compiled *Figure 6*, showing that inflows into long-only CIFs ballooned between 2004 and 2008, and again between the end of 2008 and the middle of 2010. Commodity Index Swaps, the largest contributor, until 2008 at least, are Over-the-Counter transactions and are thus explained in Section 3.6, while the red section includes most of the products detailed above (EFTs, ETNs etc) (Irwin & Sanders 2011). Total CIF investment in just five agricultural commodities (corn, soybeans, wheat, cattle and hogs) increased from around $10 billion in 2006 to over $46 billion the following year (De Schutter 2010). As a further example, Tilton, Humphreys & Radetzki (2011) estimated, using CFTC data, that by the end of 2009 CIFs held global copper futures equivalent to 6 per cent of annual global consumption; a figure around twice as high as all the copper held in inventories on the exchanges. The CFTC, quoted in Gilbert (2010) estimated that, of the $161 billion of Commodity Index-based investment evident in the United States as of end of June 2008, 24 per cent was held by the funds themselves, 42 per cent by 'institutional investors' and 9 per cent by sovereign wealth funds, with 'other traders' making up the remaining 25 per cent.

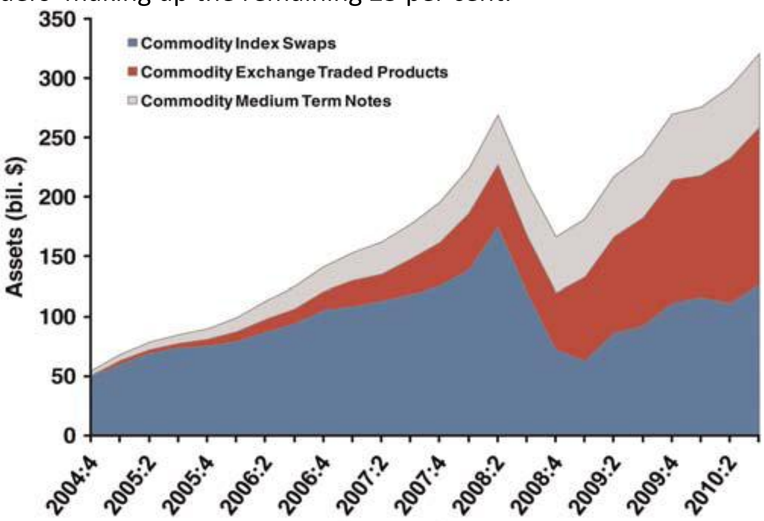


Figure 6: Commodity Index Fund Investment by category (quarterly) 1990-2009 (Irwin & Sanders 2011)

In much the same way as Equity Tracking Funds aim to replicate returns on an equities index, such as the S&P500 or the FTSE100, index funds generally track a certain commodities futures index (Gilbert 2010). The two benchmark indices are the Standard and Poor's–Goldman Sachs Commodity Index (S&P-GSCI) and the Dow Jones–UBS Commodity Index (DJ-UBSCI) (Gilbert 2010; Stoll & Whaley 2009; Irwin & Sanders 2010). The weighting of each commodity in the index is related to world production averaged over the past five years (in the case of the S&P GSCI) or by the amount of trades in that commodity during the same five years (DJ-UBSCI). The composition of these indices has remained largely stable in recent years (Tang & Xiong 2011). *Figure 7* shows the breakdowns of the two indices by asset class. It should be noted that the DJ-UBSCI limits single sector exposure to 33% of the total (Gilbert 2010; Stoll & Whaley 2009).

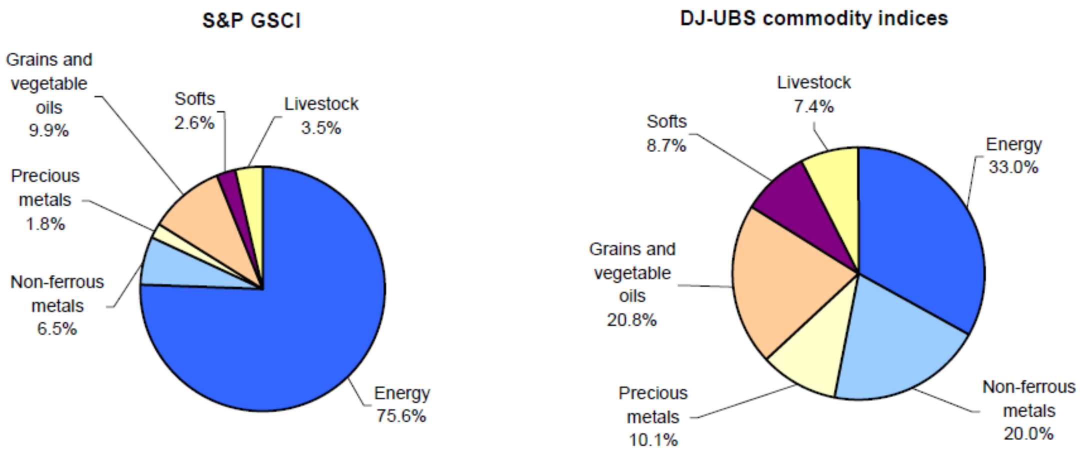


Figure 7: Commodity composition of the S&P GSCI and DJ-UBS commodity indices, as of September 2008 (Gilbert 2011)

By mid-2006, Domanski & Heath (2007) estimated that around $85 billion were tracking these two funds alone. This investment does not normally take place on commodity exchanges due to limitations on which companies can trade on exchanges (Stoll & Whalley 2009) and the cost involved. Therefore most such investment is performed by a third-party fund manager who will buy exposure to the chosen portfolio of commodities either directly on an exchange or through Over-the-Counter swap deals (See Section 3.6) (Irwin & Sanders 2011). The behaviour of the indices has played an important role in recent financial volatility. Between the peak value of the S&P-GSCI on 3 July 2008 and the collapse of Lehman Brothers 2½ months later, the index lost 37 per cent of its value, resulting in huge losses for investors holding long positions, although having bottomed-out, the S&P-GSCI continued its upward trend all the way into December 2010 (Basu & Gavin 2011), since when the increase has levelled-off. The precise extent to which Lehman Brothers was exposed to commodity index investment is obscured by the Over-the-Counter nature of these trades, but coincidence would suggest that exposure was considerable.

3.4.2a Effects of Indices

Due to the overwhelming influence of energy, especially oil, futures on the S&P-GSCI in particular, it is reasonable to assume the price of oil is the major driver of other CIF-linked commodities futures prices, regardless of fundamentals (Ghosh 2011). The CFTC has equated index fund investment with increased general futures prices for the period 2006-07, and to some extent with the doubling of wheat prices between June and December 2010 (Stoll and

Whaley 2009; Ghosh 2011). This has proved controversial, however, with both Irwin & Masters (2010) and Stoll & Whaley (2009) pointing out that correlation of increased investment in futures with higher spot prices does not prove causation. What is more, should CIFs play a dominant role in price-formation it would be visible through the contemporaneous co-movement of futures prices across the index-traded commodities, a correlation which Gorton and Rouwenhorst's (2006) study failed to find, although later studies by Tang & Xiong (2011) and Gilbert (2010) *did* find a correlation. Stoll & Whaley (2009) found correlations, but also showed that these are not necessarily linked to commodity indices. Fluctuations of prices of soybeans (index-traded) and oats (not index traded) on the Chicago markets showed remarkable similarity, implying that co-integration was not due simply to commodity indices, but rather from some other mechanism such as market fundamentals (ibid.). It should be noted that this comovement does not in itself imply that fluctuations are supply-demand driven, as commodity index trading is just one form of speculation and there may be trading strategies other than following either of the two main indices which could drive this co-integration.

Irwin & Masters (2010), meanwhile, found that increased index-based investment has possibly even led to lower market volatility (although they themselves warn about the validity of this relationship), a finding disputed by Tang & Xiong (2011), who found that, in 2008 "indexed non-energy commodities had larger price volatility than those off-index ones", a difference they suggest that was partly due to correlations with oil.

One reason that Gorton and Rouwenhorst (2006) failed to find evidence of co-movement could be that the study was too early. Tang & Xiong (2011) found that, only after about 2005 was there a notable increase in co-movement of price fluctuations between oil and a variety of other, index-traded commodities. *Figure 8* shows the rolling return correlations between copper and oil on the left and between energy and non-energy S&P-GSCI commodities on the right, where zero indicates no correlation and one is exactly correlated. These findings suggest that the price increases seen were not purely driven by increased demand from developing economies, but were "at least partially related to trading by international index investors in commodities markets" (ibid.). Interestingly, the increase in correlations between individual commodities began some three or four years before the crisis (Basu &Gavin 2011), and the correlations increased with the growth in open interest in these commodities, as laid out by Hong & Yogo (2010) and discussed briefly in Section 3.3. Tang & Xiong (2011) go further, by suggesting that many investors with exposure to the US dollar find commodities indices an effective hedging opportunity, resulting in a negative correlation between the US dollar exchange rate and commodities index prices.

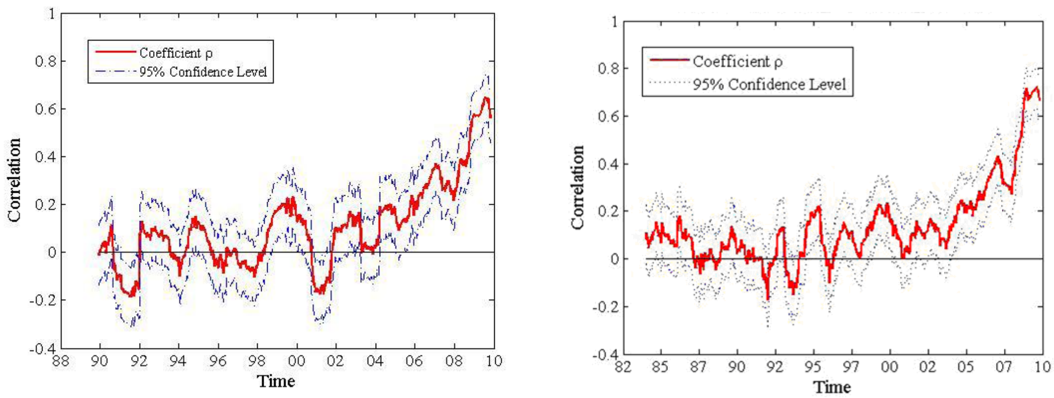


Figure 8: Cointegration coefficients of copper and oil (left) and energy with non-energy S&P-GSCI commodities (right), from Tang & Xiong (2011)

Meanwhile, Gilbert (2010) indicates that CIFs and the like may have been responsible for a "significant and bubble-like increase of energy and non-ferrous metals prices". Gilbert's study even quantifies the findings, estimating the impact of index-based investment on energy and metals prices as having increased from around 3-10 per cent in 2006-07 to 20-25 per cent in the first half of 2008. At oil's price peak in July 2008, the total value of the commodity was estimated at over $140 billion, although without index investment Gilbert (2010) showed that total investment would have been only around $115 billion. Likewise, the copper price of $8200/ton in April 2008 would have been at $6800 without the influence of index-based investment (ibid.).

3.4.3 Short-selling

Short selling effectively involves betting against the price of a stock or commodity. An amount of stock is borrowed from a company, normally through an intermediary, and sold to a third party. The stock should normally be returned within a 3 day period, so if the price falls in the period, the trader can buy the same stock for a reduced price and return it to the lender, this making a profit (SEC 2005).

Naked short selling involves selling the stock in question without first arranging to borrow it. The trader sells the stock (which could be any commodity) for a certain price, and then attempts to buy the stock to fulfil the sale within the window agreed (normally 3 days). There are no statistics on naked short selling as the practice is not necessarily illegal and regulators have not been searching for it. One sign is to look for 'failure to deliver' on contracts, caused by the trader's inability to buy the required stock within the specified time period, although this can also be due to errors or processing delays, so failure to deliver does not produce a sure-fire method for locating it (SEC 2005). Although short selling may, in distressed markets, "amplify price falls, leading to disorderly markets and systemic risks", (the EU's financial services commissioner, Michel Barnier, quoted in Moshinsky 2010), it is not widely seen as *causing* the crisis, but rather making it worse.

Short selling, especially of stocks and shares, was blamed for much of the financial turmoil and increases in systemic risk seen during the recent crisis. It even led to multinational (although short-term) ban on some types of short-selling, and has led to calls for much larger reforms (Moshinsky 2010; Market.view 2008; Etula 2009).

3.5 On-exchange Trading

Futures trading in commodities can be broken down into two categories; exchange-traded and Over-the-Counter derivatives (Etula 2010). The next two sections describe the differences between the two, some of the speculative investment vehicles associated with them and issues surrounding these two categories of investments.

Exchanges, such as the London Metal Exchange and the Chicago Mercantile Exchange, enable the trade in standardised contracts where the quantity, quality and delivery point of the commodity in question are all pre-defined. It is possible to deviate from these specifications, but extra costs are incurred in the process. The exchanges offer high liquidity and price transparency with reduced counterparty risk. Counterparty risk is managed as the exchange requires all trades to be cleared (see below), while traders must deposit an initial margin on investments and to settle all outstanding business by the end of the day (UNCTAD 2011). In doing so, the exchange also acts as the counterparty to all trades, meaning they effectively insure against counterparty risk (from defaults etc) (Basu & Gavin 2011). The difference between on-exchange and over-the-counter trades is shown in *Figure 9*. Over-the-Counter trading is largely (although not necessarily – refer to the following section) 'uncleared', meaning effectively uninsured, whereas the exchange is obliged to provide a clearing house *and* counterparty in exchange-traded deals, giving an extra level of security to investments. Despite this, less than 10% of trades of commodity futures take place on exchanges, with the remainder taking place *Over-the-Counter* (Etula 2010).

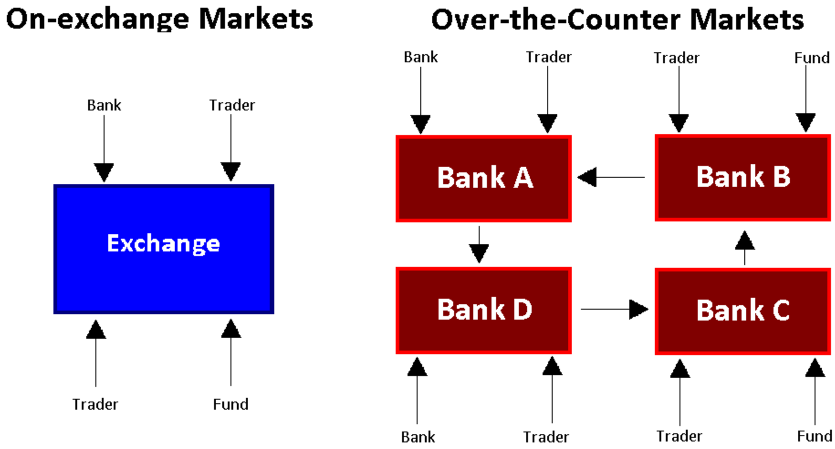


Figure 9: Schematic of the role played by the exchange in insuring against counterparty risk (left), and the direct trading between banks (without clearing) associated with Over-the-Counter trading

3.5.1 High-Frequency/Algorithmic Trading

Algorithmic trades (AT's) utilise computer-based quantitative models to predict market movements and to act upon certain situations using pre-defined protocols. Although all high-frequency trades (HFT's) use algorithms, not all ATs are necessarily HFT. While no universally-accepted definition of HFT exists, its characteristics involve the very short-term holding of investments, nominally between 10 milliseconds and 10 seconds, and the fact that positions are not normally carried overnight (Fabozzi et al. 2010). Algorithmic trading relies on open data; therefore these trades are mostly associated with on-exchange electronic trading (such as LME Select).

As *Figure 10* shows, since 2004 there has been an explosion of algorithmic trading in commodities futures, so that by 2010 over 40% of all trades on US commodities futures exchanges were done through algorithms. The reasons for this rapid rise are manifold, but can be traced to the decimalisation of US equities markets in 2001, which set the pattern for AT's in other markets, as well as increased usage of electronic exchanges, rapid advances in technology and the availability of more, and faster, data (Fabozzi et al. 2010).

The benefits, or otherwise, of HFT are still widely debated. Studies, such as by Gsell (2008) show that HFTs have the possibility to lower market volatility significantly, although they also appear to increase the likelihood of 'flash crashes', whereby trading values may plummet in a matter of seconds due to the similarity of algorithmic reactions when a certain market event occurs. The flash crash of 6 May 2010 in equities prices, and subsequent crashes in commodities (see Reuters.com 2011), is used as an example for both arguments. It would appear that the frequency of these market crashes has increased with HFT, although the subsequently rapid post-crash re-bounds are also used to show the resilience of the system in recovering (Sornette & von der Becke 2011; Fabozzi et al. 2010).

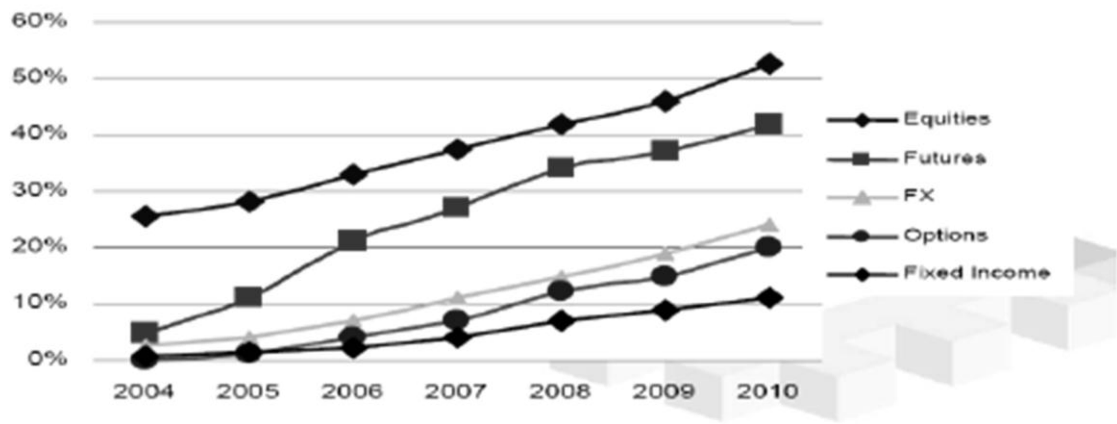


Figure 10: Algorithmic Trading adoption by asset class (Fabozzi et al. 2010)

What is more, it is widely stated that HFT increases the liquidity of markets by making more capital available, and is shown through an increase in volume of trades (Sornette & von der Becke 2011). However, since volume can be approximated as the product of liquidity and velocity of trades, higher trading volumes do not necessarily indicate higher liquidity (ibid.). Moreover, there is further evidence that high frequency traders can be "significant liquidity takers", and that "larger liquidity increases herding effects and crashes" (ibid.).

Effects of HFT's on markets were modelled by Gsell (2008). By implementing simple algorithmic trading strategies in simulations, execution of large volume trades "had a negative impact on … market prices" (ibid.). This is partly due to the inherent susceptibility of AT-dominated markets to herding effects (Sornette & von der Becke 2011). Algorithms track market activity and wider information (such as newspaper headlines), and then use past market data to predict future fluctuations. It could be expected that the outcomes of such analysis by large investors would lead to similar trading strategies across the board, resulting in the collective generation of market movements which are then identified and followed (UNCTAD 2011). The literature suggests that large transaction costs should prevent herd-like behaviour in markets (Malkiel 2003), although the movement towards electronic trading has resulted in significantly lower trading costs and has thus invalidated such an argument. Further analysis of momentum, or herd, trading is given in Section 5.3.1.

HFT has also resulted in various new strategies for manipulating markets, most of which have interesting names. 'Stuffing', for instance, involves placing a very large number of orders to create congestion and slow down the system, meaning slow traders are impaired while fast (AT) traders can take advantage of the reduced number of traders. Another strategy, called 'smoking' involves placing appealing quotes to attract slow traders, then rapidly changing the contract terms before the slow traders have time to react (Biais & Woolley 2012). 'Pinging', meanwhile, involves the placement of a buy option at a certain price. The option is then offered for sale instantaneously at a few cents extra, if no buyer is found, the sell price is reduced until a trade can be made, or until it becomes unprofitable, at which time the option is returned at no cost, or risk, to the trader.

All of this gives the impression that "fundamental information is no longer reflected in stock pricing" (James Macintosh, quoted in Fabozzi et al. 2010). Macintosh elaborates, that "pricing is now driven by market sentiment and possibly by the increase in trading on trends and patterns." (ibid.). Because large volume trades are easily traceable and disliked by regulators, many institutions "try and hide in the 'shadows' of so-called dark pools". (Bradley & Litan 2008) These 'dark pools' are opaque OTC arrangements which normally lie outside the domain of regulators.

3.6 Over-the-Counter trading

3.6.1 What is OTC trading?

On-exchange trading does not simply make price data public and transparent; it also provides insurance on every trade made on the exchange by acting as the clearing house (or middle-man) for the deal. In return for acting as the supervisor and backer of trades, exchanges charge fees and so are able to make a profit from their services. However, trades do not need to be made on an exchange; they can be performed directly between two parties. This has the advantage that the terms of a contract can be flexible regarding matters of delivery, quality or size, in order to meet the specific needs of the client (Irwin & Sanders 2011; UNCTAD 2011). Moore & Khoja (2008) explain the popularity of OTC trading with three points; firstly OTC trading allows companies to hedge exactly their risk profiles. Secondly, in making this hedge the trader is not obliged to report their daily margins to an exchange or other party, such as the regulator, and thirdly they allow for trades in commodities which are not traded on exchanges, or which do not have enough liquidity on the exchange. Sanders, Irwin, and Merrin (2010) show that around 85% of index-related positions are held by OTC 'swap dealers' (Irwin & Sanders 2011; Moore & Khoja 2008), whereby institutional investors agree to receive a certain rate of return on the specific commodity indices in which they've invested (Stoll & Whaley 2009), much like as on an exchange but normally with higher rates of return.

A gap in regulation, known as the *Swap Dealer Loophole* (see Section 4.2.3), has allowed "the greater involvement of financial investors in commodity futures trading [which] has significantly increased the positions that swap dealers hold in commodity futures contracts." (UNCTAD 2009). As swap dealers were generally considered commercial traders, this "allowed them to be exempted from regulation regarding speculative position limits. But contrary to traditional commercial traders, who hedge physical positions, swap dealers hedge financial positions." (ibid.). Reform of the CFTC's weekly *Commitment of Traders* reporting to make swap dealers a distinct trading category has gone some way to alleviating this loophole (see Section 3.2 for more on categories of traders, and Section 4.3.2 for the reasons why OTC trading is proving such a headache for the legislators)

The recent growth in commodities futures trading took place both on-exchange and over the counter, although the latter saw an increase an order of magnitude higher than the former (Basu & Gavin 2011). Due to the nature of OTC markets, exact statistics are not available, however in June 2008, at the peak of the price boom, the CFTC estimated the total notional value of commodity futures and options to be $946 billion, or approximately 85% of all outstanding commodity derivatives investment (Etula 2010). Meanwhile, the Bank of International Settlements estimated the total notional value of *all outstanding* OTC commodity derivatives contracts at the peak to be $13.2 trillion (ibid.), compared to $6.4 trillion in mid-2006 (Domanski & Heath 2007) and $3.6 trillion at the end of 2005 (Cox, Lynton & Wells 2007). This further compares with OTC investment of around just $450 billion in 1998 (Domanski & Heath 2007), and corresponds to growth of 3,000 per cent in just ten years. Using BIS statistics, *Figure 11* (left) shows the comparative growth in the gross market value of OTC commodities futures against OTC equities derivatives in the 12 years to June 2010. The spike in commodities trading in June 2008 is exceptional, and at a level almost twice that of equities. The right-hand plot, meanwhile, shows that this investment growth was not driven by gold, the traditional commodity used to hedge against inflation and other risks but not featured on either of the main commodity indices, but rather by the basket of other commodities (Basu & Gavin 2011). OTC trading in commodities derivatives, unlike on-exchange trading, has continued to decrease since 2008 (ibid.)

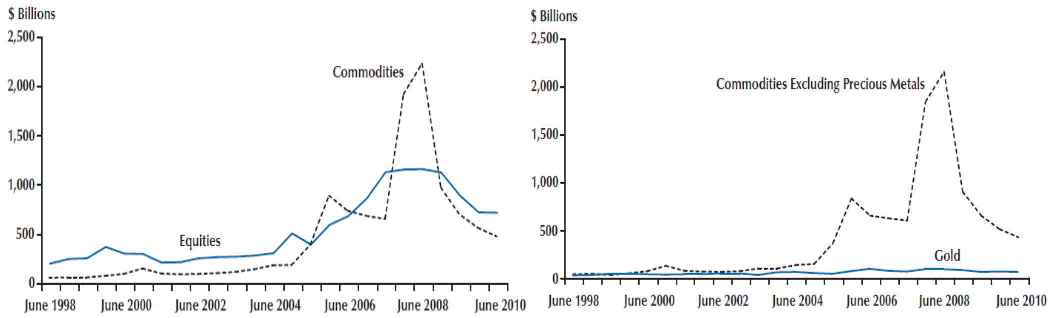


Figure 11: Left graph shows OTC trading in Commodity derivatives compared with equity derivatives (gross market values), from June 1998 to June 2010, while the right-hand graph shows OTC commodity futures without precious metals and OTC investment in gold (Basu & Gavin 2011)

3.6.2 Issues associated with OTC trading

The increase in OTC trading leading up to 2008, both in commodities futures and in other markets, not least sub-prime mortgages, is seen by many (including President Obama) as being at the centre of the market failure which led to the recent financial crisis (Basu & Gavin 2011). As such, the 2010 *Dodd-Frank Wall Street Reform and Consumer Protection Act* (see Section 4.3.1) includes proposed regulation to limit the use of OTC derivatives and to make these deals more transparent (ibid.). The following paragraphs detail some of the issues surrounding OTC trading, while Section 4.2.3 will look at the regulatory loophole which has aided the growth in OTC swaps.

While it is debatable as to the level of influence that financialisation has had on spot prices, the effect on risk has been obvious. As futures markets logically sum to zero, should one side of a deal make a profit, the other side will lose. An increase in trade volume means more winners but also more big losers. As OTC trades are made between two counterparties, rather than through an exchange, the two parties are not obliged to declare the trades or the risks/losses which they subsequently hold, therefore making large trades especially susceptible to counterparty default risk. The pricing of such risk has enjoyed a great deal of attention since the start of the credit crunch, but there is no consensus on how this should be done as data is scarce (an example, however, can be seen in Brigo, Chourdakis & Bakkar 2008). Etola (2010) suggests that the pricing of risk should depend on the broker-dealer's risk aversion, and that eventually this OTC risk premium will be incorporated into the returns on *exchange-traded* derivatives. However, as many of the firms dealing in OTC markets are considered 'too big to fail', the risk of these transactions is effectively transferred to the tax payer; should the counterparty default, the public exchequer is expected to 'bail out' the too-big-to-fail bank. As Basu & Gavin (2011) point out, there is a public interest inherent in prevention of this kind of "large-scale betting", as the tax payer is ultimately liable for those deals which go wrong.

OTC trading does not require the use of either clearing (effectively insurance) or collateral to be put up against the deal. What is more, should companies decide to collateralise, there are no set terms for how this should be done (ISDA 2010). UNCTAD (2011) reports that, of the 39 per cent of oil derivatives that were traded on OTC markets in 2010, more than 50% was uncleared, leading the UK's financial regulator, the FSA (2009) to observe "shortcomings in the management of counterparty credit risk and the absence of sufficient transparency" and the International Organization of Securities Commissions to assert that "that substantial counterparty risk is an issue" to the global economy (UNCTAD 2011).

The lack of transparency does not simply have risk implications; there are also problems around price discovery in OTC markets. As data on forward pricing and market volatility is not transparent, traders use reporting agencies, such as *Platts* or *Argus*, to provide them with thousands of daily reference prices (Moore & Khoja 2008; UNCTAD 2011). As Moore & Khoja (2008) make clear, however, these survey prices are not necessarily based on bids and offers, but rather on trader opinion, resulting in a possible mismatch between real market conditions and prices paid in OTC deals. They continue that the problem has been exacerbated since the start of the credit crunch, not least because traders struggle to explain past and current commodity valuations to auditors, and thus accurate posting of collateral for such trades is naturally uncertain. It should be noted that commodity derivatives are more complicated than other markets due to the amount of variables, such as grades of commodities and physical location of the stock, which do not exist on such markets as foreign exchange or equities, and which therefore make effective pricing all the more difficult (Moore & Khoja 2008), although until recently regulators regarded all these markets to be equivalent, and therefore subject to the same, light-touch regulation.

4. Regulation

4.1 Historical

When discussing historical legislation of commodities trading, the Wall Street crash of 1929 looms large. Much of the regulation still discussed today (such as the US Glass-Steagall Act) were enacted as a response to 1929 and earlier crashes, when the price of commodities first rose and then collapsed (Markham 2004). Following on from the 1922 Grain Futures Act, the Commodity Exchange Act (CEA) of 1936 was adopted to give the US Federal government wide-ranging powers to act against the many abuses that had been found within the industry (Markham 2004; Paul 1980). The Act prohibited the manipulation of commodity futures markets, obliged all trading to take place on organised exchanges and gave the regulatory bodies powers to impose speculative position limits on traders (Markham 2004).

Over the next 40 years the CEA was amended on numerous occasions to cater for various unforeseen factors in the original legislation, and finally in 1974 the Commodities Futures Trading Commission Act was passed, creating a new body (the CFTC) with responsibility for approving or revising contract terms to help prevent manipulation of commodities futures markets (Paul 1980). As with its predecessor, the 1974 Act stipulated that all commodity futures trades must take place on CFTC-regulated exchanges, not least because the derivatives market was seen as being highly susceptible to manipulation or speculation, causing artificial price setting and instability (Jickling 2003).

The new Commission soon encountered some serious issues. Formally it was given 'exclusive' jurisdiction over commodities futures trading, but this was met with resistance, not least from the well-established Securities and Exchange Commission (SEC), which was responsible for overseeing professional financial markets where off-exchange trading of futures and options contracts was considered the norm (Jickling 2003). As OTC derivatives trading grew during the 1980s the SEC and CFTC clashed repeatedly over the regulation of these markets (Jickling 2003). The stock market crash of 1987 was blamed by the SEC on "the destabilizing effects of futures trading on commodity indexes" (Markham 2004) while two years later the CFTC issued a Policy Statement taking the position that most OTC swap deals were "not appropriately regulated as futures contracts under the CEA" (Gensler 2010).

During the late '80's and early 1990's questions over the legal status of the Swaps market began to be asked in Congress. The Futures Trading practices Act of 1992 was designed to answer some of these questions, but when the bill finally came into place in January of the next year the 'Exemption for Certain Swaps Agreements' loophole meant that the Act had virtually no teeth (Gensler 2010).

Meanwhile, as the laissez-faire attitude of the SEC gradually won the ideological battle over the more conservative CFTC, trading in OTC derivative swaps ballooned, so that by 1998 the notional value of outstanding OTC swaps was estimated to be $80 trillion, against the equivalent on-exchange value of just $13.5 trillion (Gensler 2010). The CEA was now looking very outdated in its prescription of on-exchange regulated trading, and so the Commodities Futures Modernization Act of 2000 was signed in by President Clinton to usurp much of the 1936 Act (Cravath, Swaine & Moore 2001). Rather than being an Act of regulation however, the Commodities Futures Modernization Act deregulated virtually all commodities markets except where retail customers were involved (Markham 2004). Some of the consequences of this deregulation are discussed below.

4.2 Loopholes

A loophole is a gap in legislation which allows companies or traders to take advantage of a situation to avoid sanctions and therefore profit from actions which would not otherwise be possible or legal. The Commodities Futures Modernization Act of 2000 created a number of loopholes, three of which are discussed in the following subsections. Of the three, the first has now been legislated for, the second has been partly dealt with, while the last is still a matter of serious contention.

4.2.1 The Enron Loophole

The Commodities Futures Modernization Act of 2000 was a key piece of US legislation in the de-regulation of commodities markets. One clause in the legislation, apparently inserted by Enron-backed Republican senator Phil Gramm (Lipton 2008), exempted energy trading on electronic platforms from regulation. At the time Enron's electronic energy trading platform, *Enron Online*, was both the market leader and major trendsetter (UNCTAD 2009). The situation, later known as the Enron Loophole, came to a head when Enron's traders used their own platform to create artificial energy shortages in California through a number of imaginatively-named schemes. The rolling blackouts experienced throughout 2000-01 resulted in extra energy costs of around $40 billion – much of which presumably went in profits to the energy companies (mainly Enron) (Goyette 2011). The same issue raised its head again in 2008 when oil, largely traded on similar, un-regulated electronic exchanges, hit $135 a barrel (Hill 2008).

Under pressure to regulate, the CFTC proposed legislation which later formed a part of the 2008 US Farm Bill. The bill gave the CFTC the powers to regulate those exchanges which "perform a significant price discovery function", as well as obliging the exchanges themselves to report to the commission and to monitor trades to "prevent market manipulation, price distortion, and disruptions of the delivery or cash-settlement process" (Jickling 2008)

4.2.2 The London Loophole

A similar state of affairs arose around the same time which cannot be overcome merely by legislation. Under the London Loophole, benchmark energy futures contracts are traded at the same time on the NYMEX in New York and on London's [US-owned] InterContinental Exchange (ICE) (UNCTAD 2009). US energy companies, trading US-delivered commodities, are able to take advantage of 'regulatory arbitrage' to choose the venue of their trades which would be most advantageous, while avoiding the CFTC's market reporting obligations and safeguards (like position limits) (Chilton 2008). A major push to regulate this area was defeated in Congress in June 2008, and there remains no formal US legislation to regulate such circumstances (Levin 2008). During 2008 the CFTC, ICE and the UK regulator, the FSA, were able to form a voluntary agreement to set position limits on oil contracts delivered to the US. However the agreement did not cover other contracts such as Brent Crude and gas oil, the major European future for diesel and heating oil (Farge & Sheppard 2009).

Although many claimed that the voluntary agreement had solved the issue, it does not appear to be the case. In June 2009, around the time that oil was touching $150 a barrel for the first time, front-month gas contracts on the ICE hit an all-time high of 113,400 lots traded, with some traders reportedly holding 50,000 lots. The CFTC limits positions in heating oil on the equivalent, US-based NYMEX to 7,000 lots in order to avoid excessive speculation (Farge & Sheppard 2009). The FSA prefer light-touch regulation, and are largely against the imposition of position limits. Speaking to Reuters, a representative of the Authority was quoted in 2009 as saying "In order to satisfy the requirement to operate markets which are fair and orderly at all times, all UK exchanges have incorporated broader position management powers into their rules" (Farge & Sheppard 2009). Position management is examined more closely below. Meanwhile the London Loophole apparently remains, and begs the answer to deep questions as to how regulation of international exchanges can be achieved without international consensus and increased cooperation.

4.2.3 The Swap-Dealer Loophole

The so-called 'Swap-Dealer Loophole' has attracted a lot of attention in the current debate on required regulatory changes (UNCTAD 2009a). As discussed in Section 3.6.1, a swap is basically an arrangement between two parties to buy and sell options or futures contracts. A loophole in the Commodities Futures Modernization Act of 2000 allowed all swap trading to move off exchanges and into OTC markets, meaning there is no requirement for the deal to be either declared to the regulator or insured through exchanges or clearing houses (Ghosh 2011; UNCTAD 2009). Swap markets were traditionally used by 'commercial' traders to "hedge their price exposures with long futures positions in commodities," however modern swap dealers do not generally hedge physical positions, but rather financial ones such as commodity indexes (UNCTAD 2009a; Ghosh 2011). In other words, financial traders and institutions have used the loophole to buy commodity futures as a form of insurance against financial positions, but because all this occurs OTC, the regulator has no access to data and no authority to impose limits on the trades.

The solution to this situation appears obvious – to require all commodity futures trading to be performed on exchanges. The issue is that there is now a lot of capital tied up in these OTC swaps (in June 2008 the CFTC estimated the total notional value of OTC commodity futures and options to be $946 billion (Etula 2010), although compared with many of the other estimates found throughout this thesis that estimate appears rather conservative). Therefore financial institutions are lobbying hard to be allowed to continue to trade in such a way. Dodd-Frank (see below) allows for the CFTC to categorise swap dealers as such, and regulate them accordingly. It should be remembered that certain traders use these arrangements legitimately, so a threshold was devised, based on the size of a company's OTC commodity options. Below that limit traders would be permitted to continue as normal. In December 2010 this limit was set to apply only to market parties making over $100 million in OTC commodity trades over a 12-month period - meaning any market actor that traded more than that would be considered a swap dealer. By April 2012 however, Reuters were reporting that the definition of swap dealer would only apply to traders with more than $8 billion in annual OTC trades (Alper & Lynch 2012), an increase of 80 times. This threshold will fall to $3 billion at some point, although in total the regulation is now likely to affect just 125 entities. The CFTC would not elaborate on whether this was at the $8 billion or $3 billion mark (ibid.). Following the announcement, CFTC commissioner Bart Chilton commented that, in setting this "arbitrary" limit, it would be hard to call the threshold "a *de minimus* limit … without laughing" (Scheid 2012).

4.3 Current and proposed Legislation

At the G20 Pittsburg summit in September 2009, the represented governments agreed "to improve the regulation, functioning and transparency of financial and commodity markets to address excessive commodity price volatility" (European Commission 2011a). Having made the commitment, work started on both sides of the Atlantic to write and enact wide-ranging legislation to try and prevent abuses of the financial system. The following section looks at and compares current US and European regulations.

4.3.1 MiFID and Dodd Frank (history and context)

In Europe, the *Markets in Financial Instruments Directive* (MiFID) first came into force in November 2007. Actually a directive and a regulation[3], MiFID worked towards the objective of furthering "the integration, competitiveness, and efficiency of EU financial markets" (European Commission 2011a). The original MiFID encouraged competition between European exchanges and gave greater allowances for OTC arrangements by taking away the ability of member states to require all trading to take place on traditional exchanges (ibid.). However, the subsequent financial crisis "exposed weaknesses in the regulation of instruments other than shares [i.e. commodities], traded mostly between professional investors" (European Commission 2011b). Combined with unforeseen technological innovations in Algorithmic Trading, MiFID's assumptions that "minimal transparency, oversight and investor protection in relation to this trading is more conducive to market efficiency" have been proven incorrect, in the case of commodity derivatives at least (ibid.). Therefore a revision of MiFID, commonly referred to as MiFID II is currently underway. At the time of writing the proposals detailed below are being discussed in the European Parliament. The UK's FSA (2012) expects political agreement by the end of 2012 and the possibility for implementing measures to be in place by 2015.

MiFID II, also a combination of a regulation and a directive, seeks to increase transparency through provision of data for both the public and regulating authorities, improves access to clearing, makes it a requirement that all commodity trading is done on organized venues (see Section 4.3.2), enables EU regulators to set positional limits across the Union and clarifies the powers available to competent authorities to regulate and prosecute as appropriate (European Commission 2011b).

On the other side of the Atlantic, as a response to the financial crisis and subsequent bail-outs, the Dodd–Frank Wall Street Reform and Consumer Protection Act was passed by the US Congress, and signed into law by President Obama in July 2010. The bill is vast and its remit wide, but some aims of relevance to this investigation included; promotion of financial stability by improving accountability and transparency in the financial system, curtailing of abusive lending practices and high-risk betting as well as calling for public exchanges on which derivatives (including commodities) would be traded (Times Topics 2011; H.R.4173 2009).

The Dodd-Frank Act seeks to increase federal financial regulatory powers while obliging obscure OTC trades to be more transparent. For commodities, this means forcing derivatives trading onto open marketplaces within view of the regulators. It must be stressed, however, that the Bill, on its way through Congress, was a major political battleground. Indeed, although the Act has already been passed, there remain major obstacles to its implementation. By September 2011 only around a quarter of the 400 new regulations required by Dodd-Frank had been written, while at least 20 Bills were introduced to curtail specific parts of the Act (Times Topics 2011).

4.3.2 Obliging the use of regulated exchanges

A G20 agreement calls for all "trading in standardised OTC derivatives [to] move to exchanges or electronic trading platforms where appropriate" (European Commission

[3] An EU regulation is binding legislation, passed by one or a combination of European Institutions, which is equal throughout the Union. A directive, meanwhile, is more of a guideline which member states have to interpret and take action to make it law in that particular country (European Commission 2011c)

2011b). This was the case for over 60 years up, until the turn of the millennium, whereby a major pillar of the US regulatory system required commodities to be traded on regulated exchanges under the auspices of the CFTC. There were four guiding principles to this legislation, none of which apply necessarily to OTC trading. These principles were "1) the disclosure of positions by traders; 2) capital requirements for organizers of exchanges; 3) margin requirements for traders; and 4) position limits for traders" (Ghosh 2011). The Commodities Futures Modernization Act of 2000 changed that attitude and allowed for the huge expansion of commodity derivatives investment which is currently being re-regulated for (Ghosh 2011). While both in Europe and the US there is equal clamour to bring OTC transactions into the light of the regulators, the approaches differ slightly in emphasis. The Dodd-Frank Act simply requires registration of swap dealers (as discussed in Section 4.2.3), while MiFID puts more emphasis on bringing those trades onto organised and regulated exchanges, although it should be mentioned that Dodd-Frank also makes allowances for bringing OTC transactions onto exchanges (Clifford Chance 2010; European Commission 2011b)

MiFID II obliges commodity futures trading to take place on one of three different types of regulated trading venues. These include traditional regulated markets, multilateral trading facilities (sometimes referred to as 'Exchange Lite') and organized trading facilities (bought in as part of MiFID II to encourage OTC swaps to take place through a clearing facility, within view of regulators) (European Commission 2011b; Grant 2010). The three trading facilities have many similar requirements, including those for pre- and post-trade transparency, market surveillance and requirements for neutral operators of exchanges that will provide "non-discretionary execution of transactions" (European Commission 2011a; European Commission 2011b). As Price (2011) points out, this will, in theory, make it impossible for Investment banks to use their own capital to trade – this has been law since the 1930s but has become impossible to enforce with the ballooning of OTC trading.

Much effort has been made in the United States to force derivatives onto open exchanges. A number of Bills, not least those introduced by then chairwoman of the Senate Agriculture Committee, Blanche Lincoln, have attempted to reign-in OTC derivatives Swaps. However, it appears that Wall Street remains strongly opposed to such measures, as they would introduce price competition and lower profits. Instead, Wall Street appears to favour a "Clearing House" approach (Times Topics 2011) as discussed below.

4.3.3 Clearing

One major advantage of on-exchange trading is that all trades performed on the exchange are passed through a clearing mechanism, meaning the trade is insured should the counterparty not be able to fulfill their obligations (by going bankrupt, for instance). As discussed in Section 3.6.2, it is a major concern that many OTC trades are not cleared, significantly increasing counterparty risk. It is a stated aim of both Dodd-Frank and MiFID that all trades should be cleared, although once again the emphasis is slightly different.

As shown in the proceeding sub-section, MiFID would appear to be stronger than Dodd-Frank in calling for all OTC trades to be moved onto exchanges. However, the EU is concerned at the lack of competition amongst clearing houses within the trading block. Previously, exchanges would oblige traders to clear their trades through the exchange, creating a 'vertical silo' whereby the exchange controlled both the trading and clearing of instruments on their exchange (Price 2011). It remains the responsibility of the exchange operator to ensure derivatives are cleared, but the operator can no longer bar market participants from clearing their deals through a third party, even if that clearing house is abroad (European Commission 2011a; European Commission 2011b)

Dodd Frank is less specific on the requirements from exchange operators, but it does oblige *all* security-based swaps to be cleared through a registered clearing house. The counterparty is entitled to choose the clearing venue, but that clearing organization must report all swaps and trades to the CFTC in order that they can monitor the actions of market participants, and in so doing will be able to enforce other rules onto traders, such as position limits (H.R.4173 2009).

4.3.4 Position Limits

Amidst great pressure following the Wall Street Crash of 1929, the Commodity Exchange Act permitted the regulator to "proclaim and fix such limits on the amounts of trading which may be done or positions which may be held by any person" (CFTC 2010). Up until 2001 all energy futures were subjected to position limits, and indeed the CFTC still sets limits on certain agricultural and oil-based derivatives. However, the length of contracts subjected to position limits in the US has been reduced, so that now NYMEX applies limits to the final month before maturity, while by 2008 the CFTC was only setting limits for the final three days of trading on a contract (CFTC 2010; Mandaro 2008)

Position limits are employed to prevent large speculators from taking excessive power over the market – normally by controlling the supply-side of futures markets by taking very large positions, either short or long, and thus influencing the spot price (Ghosh 2011). Both Dodd Frank and MiFID permit the establishment of Position Limits to all parties except "bona fide hedgers" (H.R.4173 2009). According to Ghosh (2011) it is important that commercial hedgers, such as agricultural producers, be exempted from such legislation as, in theory, hedgers cannot speculate. However, large agribusinesses will still be able to take dominant positions in the market, and therefore exert undue influence.

The rules for these position limits must ensure non-discrimination, they must be clear and simple and take into account specific issues associated with the exchange in question (European Commission 2011a; Ghosh 2011). The rules will also be applied equally throughout the area covered by legislation (European Commission 2011a). Nonetheless, position limits remain controversial and challenges to the legislation can be expected for some time.

4.4 Other Regulatory Options

A number of alternative regulatory measures to those discussed above have been proposed to counteract the effects of speculation in financial and/or commodities markets. The following is a brief summary of a selection of those proposals.

4.4.1 Financial Transaction (Tobin) Tax

An idea much discussed in certain circles since the onset of the Crisis has been to tax financial transactions (financial transaction tax, FTT). The concept was first proposed by JM Keynes in the 1930s, and developed by James Tobin in his influential work from the late 1970s (Tobin 1978). The main idea is that a small tax on every financial transaction be levied in order to reduce the frequency of noise, or herd trades (see Section 5.3.1) made by speculators. In doing so, this should lead to a decrease in market volatility and an increase in market efficiency (see Section 5.3) (Huber, Kleinlercher & Kirchler 2012).

In order to test the validity of Tobin's original assertion, a multitude of papers have been written on the subject, mainly dating from the 1990's onwards. There is general agreement that a tax would lower trading volumes and would also decrease the market share of taxed markets, compared with untaxed ones. Empirically, some studies have shown a decrease in volatility when considering rational actors or zero-intelligence (i.e. herd) traders. However other studies, especially considering small, unilaterally taxed markets, have shown the opposite. For that reason, the FTT remains controversial. Proponents of the tax, including the UN office of the High Commissioner of Human Rights (OHCHR), promote the idea of the levy as a means of reducing government deficits and reducing global inequality, as well as helping to discourage speculation. The OHCHR (2012) estimates global benefits to public exchequers to be worth around $250 billion per year. That said, other studies such as one performed by Ernst & Young and reported in the Daily Telegraph, suggest that a unilateral, EU-wide FTT could *cost* EU public finances €116 billion per year (Cooper 2012)

Given the wide-range of estimates as to the benefits or otherwise of a FTT, the literature sets out some terms which would be required to ensure the success of a FTT scheme. Firstly, it would have to be multilateral, covering as many markets as possible. Care should also be taken to ensure the tax is large enough to discourage noise traders, but not so large that it prevents the market from functioning correctly. As such, there may be a case for an adjustable tax rate dependent upon market volatility, so that the small tax can be increased in order to prevent speculation on already highly-volatile markets (Pellizzari & Westerhoff 2009). There is also a suggestion that this tax be used in a Pigouvian manner, whereby the worst perpetrators (namely High-frequency traders and the like) be taxed at a higher rate, while other, genuine market parties be taxed less or receive exemptions from the FTT (Biais & Woolley 2012). All of this implies that the tax should be set as an economic necessity rather than a political tool for making money, although as arguments continue about a global or regional FTT the matter appears increasingly political.

4.4.2 Volcker Rule

The Volcker Rule, proposed by the former chairman of the US Federal Reserve, is a piece of legislation that has come out of Dodd-Frank. It seeks to restrict banks from using their own, federally-insured deposits from trading for their own benefit. Although contested, much of the rule has been accepted by both legislators and financial institutions, with the final agreement limiting banks' investments in hedge funds to 3% of their tangible equity (Times Topics 2011).

Although not immediately obvious, the Volcker Rule could also be applied to commodities futures. Banks often use commodities futures to hedge their other investments. If they are party to non-public information, and use that information to bet against the interests of their clients, they would essentially be breaking the law. Likewise, a very large trader who buys enough market share to influence the market, then makes political gestures to increase the value of their investment, would be acting against the rule (Ghosh 2011). Such a situation occurred in 2011 involving trader Glencore buying a dominant share in the grains market, then using their political influence to encourage the Russian government to impose export restrictions, thus increasing the value of their investment (Blas & Farchy 2011). The Volcker rule has to be tested in relation to commodities futures, with many financial institutions insisting that commodities futures do not fall under the remit of the legislation, due to their fundamentally unique nature. However, it appears that regulators in the US are keen to prevent the opening of a loophole in the new legislation, signalling that the application of Volcker to commodities futures could be an upcoming area of dispute between Wall Street and the regulators (Sheppard 2012).

4.4.3 Other options

A plethora of other ideas exist to improve the functioning of commodities markets. Below are just three such examples.

Capital/Margin requirements

In April 2012 President Obama authorised the CFTC to oblige clearing houses to increase their margin requirements, the amount of money centrally deposited by traders when confirming a deal, on oil futures. The rule change will increase trading costs to customers with unhedged (or speculative) positions, in theory reducing the amount of speculation on those markets. A major clearing house in the US, ICE Clear Credit, says it will increase its requirements by around 10% (Stafford 2012). As so often with financial regulation, this move has been met with opposition from economists and traders, who argue that the move will push small traders out of the market and leave room only for those traders large enough to hedge their speculative investments, thus reducing liquidity and increasing volatility (Sheppard 2012). It remains to be seen what the actual impact of this policy will be.

Minimum latency

The increased use of HFT (See Section 3.5.1) has led to calls for these trades to be subjected to precise regulation to counter issues associated solely with AT or HFT. One such idea is to oblige a minimum latency time of trades. This would require orders to remain on the order book of a company for a minimum time before they could be traded or cancelled (European Commission 2011d). This would appear to be a simple and effective mechanism to prevent market manipulation such as ‘Pinging’, outlined in Section 3.5.1. Opposition seems to revolve around the idea that these ‘speed limits’ would deter innovation, although as Biais & Woolley (2012) point out, this same criticism applies to speed limits on roads, and in any case it is hard to believe that a move from 1 millisecond per transaction to 1 tenth of a second would have a great, negative impact on either technological progress or on the efficiency of the market.

Order-to-executed transaction ratio

Another piece of HFT legislation being discussed by the European Commission is to regulate the amount of orders that can be cancelled, against those actually transacted by the trader. It would mitigate such strategies as pinging, which results in numerous cancelled orders when buyers cannot be found, as well as reducing stress on the system by lowering the amount of orders placed (European Commission 2011d).

5. Theoretical framework

5.1 Relationship between Spots and Futures

In general, prices in the futures market have a predictable relationship with cash or spot prices. Typically, as shown in *Figure 14*, spots and futures prices will converge as the delivery date for the futures contract approaches (USSSI 2009). The future spot price of a commodity is unknown, so the futures price reflects to some extent the expected future spot, although it is not seen as a true predictor of the future spot (Gorton & Rouwenhorst 2005).

The explicit relationship between spots and futures prices remains a hot topic. Gorton & Rouwenhorst (2005) showed that fluctuations in spots and futures are highly correlated (as shown in *Figure 12*), and that these correlations increase in times of market volatility. The question of whether futures prices drive spot prices or vice versa is still widely contested, however. Tilton, Humphreys & Radetzki (2011), using theoretical models, show that futures prices have a major influence on spots only when the market is in strong *contango* (refer to the following sub-section for explanation), while under other market conditions any impact of futures on spot prices are “much looser” (ibid.). On the other hand, empirical studies by Hernandez and Torero (2010) show, using Granger causality tests (see Section 6.6.2), that for the studied agricultural commodities “the information flow from futures to spot markets has intensified in the past 15 years” (UNCTAD 2011), implying that the “return in the spot market today is significantly related to past returns in the futures market up to at least 10 weeks ago, whereas the impact of past spot returns on today’s futures return is generally not significant” (Hernandez and Torero 2010). The following sub-sections will investigate, both theoretically and empirically, what the literature implies about this relationship, although first a key relationship must be explained.

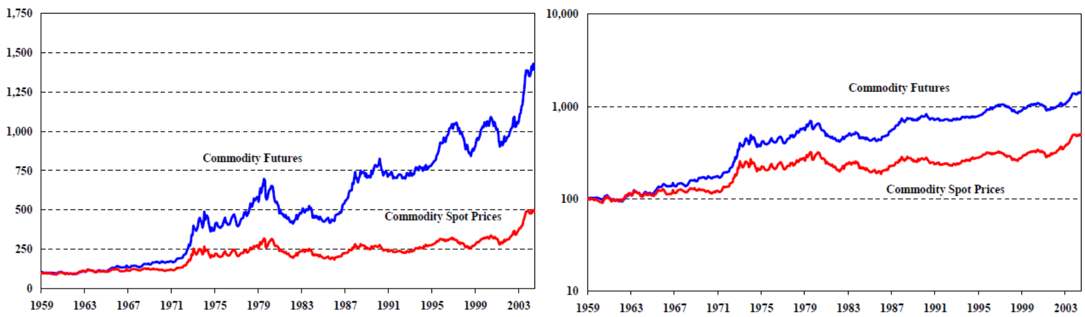


Figure 12: Left: Commodities’ Inflation Adjusted Performance (Normalised) from July 1959 to December 2004. Right: same graph with log y-axis shows more clearly the correlated fluctuations (Gorton & Rouwenhorst 2005)

5.1.1 Contango and Backwardation

There are two ways in which futures and spot prices are obviously related; either the futures price at time of purchase is higher than the spot price, and falls to meet the eventual future spot in a situation known as *contango*, or the futures price is less than the spot, and hence rises to meet the future price. This is referred to as *backwardation*. As the delivery time of the contract approaches, the futures and spot prices become closer to each other in a process known as convergence. (Harper 2007; USSSI 2009). Gold, for example, has been in contango almost continuously since 1975, due to the high level of above-ground reserves, whereas copper is normally in backwardation, except for a 5-year period between 2004 and 2009 where the price apparently was based more on futures than spots prices, as shown in *Figure 13* (Domanski & Heath 2007; Otto 2012)

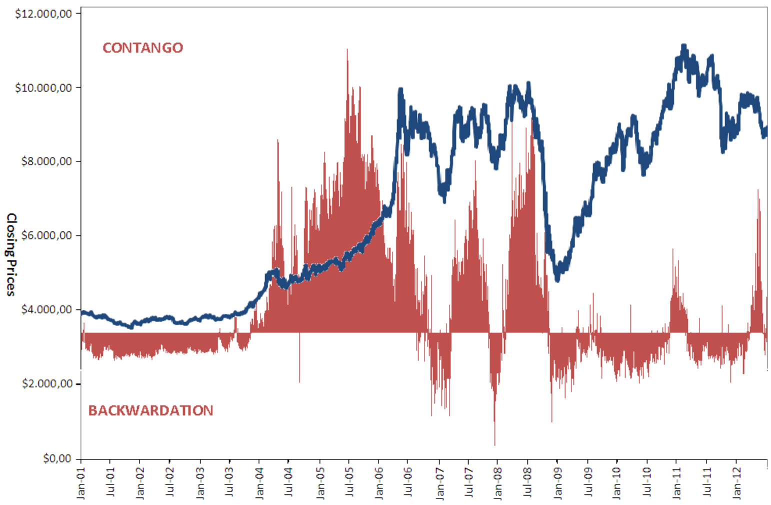


Figure 13: Contango and Backwardation between spots and 3-month futures in LME Grade A copper (red bars), plotted against daily closing spot prices of the same grade (blue line)

The underlying causes for these effects are discussed in the following sub-sections, but their implications are well-known and uncontroversial. In a *contango* market, investors will buy real commodities on the spot market, and sell them as a future. In economic parlance, the trader will short the futures contract and then buy the underlying commodity for delivery, thus making a profit. In a *backward-ated* market the opposite is true. Traders short the actual commodity and buy futures (Harper 2007). The effects of these two mechanisms lead logically to convergence, as shown in *Figure 14*.

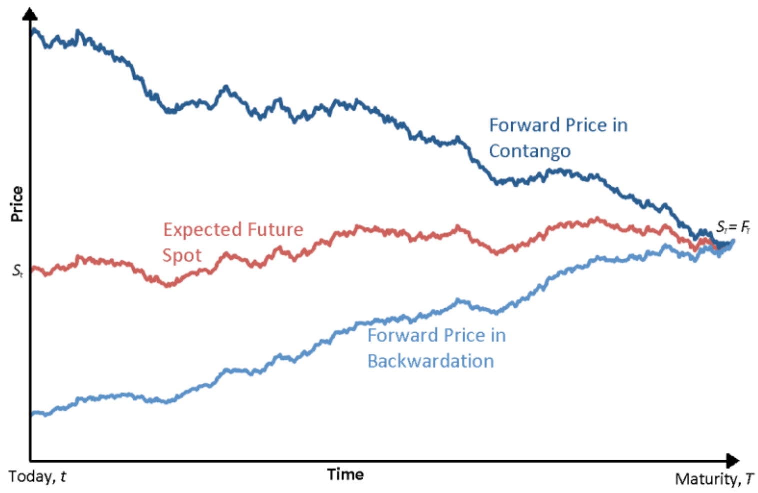


Figure 14: Futures price of a contract against time to maturity

It should be noted that in recent years, certain commodities contracts, such as US wheat, have failed to converge due to abnormally high futures prices (normally in contango), leading to a highly unpredictable spot market (USSSI 2009). Stoll & Whaley (2009) point out that this failure to converge does not impact the effectiveness of the contract as a risk management tool, because futures returns remain highly correlated with expectations.

5.1.2 Arbitrage

Arbitrage is the means by which futures and spot prices will converge. If the futures price deviates from the spot price plus transaction costs (including interest and storage), arbitrageurs will be able to buy on one side and sell on the other, thus making a (virtually) risk-free profit *and* causing the prices to converge (Domanski & Heath 2007; Tang & Xiong 2010). This works well in highly liquid markets like equities and FX, but as Domanski & Heath (2007) put it, "the scope for arbitrage in commodity markets may be limited by constraints on short selling [Section 3.4.3]. In particular, the stock of commodities available for lending is generally small for energy and base metals". This may help to explain why futures and spot prices on Chicago wheat have recently failed to converge.

5.2 Theories of spots and futures markets

There are two primary theories governing the relationship between spots and futures prices. They are not mutually exclusive, but rather look at the relationship from different frames of reference. The 'Theory of Storage' is "the dominant model of commodity forward and futures prices" (Fama and French 1988) relating the futures price of a commodity to the spot price plus a 'cost-of-carry' factor which contains the anticipated profit, known as the convenience yield or risk premium (Fama & French 1987; Büyükşahin 2008). The second major theory - less accepted and with more constraints than the first – is the 'Theory of Normal Backwardation' as espoused by Keynes and Hicks in the 1930s (Gorton, Hayashi & Rouwenhorst 2008). The theory refutes the idea that futures prices are an indicator of future spot prices, but rather that the risk premium would, on average, "accrue to the buyers of futures" (Chang 1985; Gorton & Rouwenhorst 2005).

5.2.1 Theory of Storage

The theory of storage uses the idea of the *basis* – the difference between the current spot price at time t, S_t, and the futures price at time t with delivery at time T, $F_{t,T}$. The basis is calculated as follows

$$F_{t,T} - S_t = S_t r_t + w_t - c_t(I)$$

where $S_t r_t$ is known as the cost of carry, the sum with interest forgone when investing in the commodity (r_t is the interest charged per dollar for the period T-t); w_t is the marginal storage cost and $c_t(I)$ is the convenience yield as a function of inventories, I, sometimes referred to as the risk premium, which is effectively the profit for the speculator (Gorton, Hayashi & Rouwenhorst 2008; Fama & French 1988). According to Fama & French (1987), the size of the convenience yield is inversely related to the size of inventories of the commodity in question, and in certain cases is also related to the interest rates (although the cost of carry component also includes interest rates). This is logical, because at low inventory levels traders can be expected to demand a higher risk premium due to the increased volatility effects from lower inventories, leading to the risk of stock-outs (Gorton, Hayashi & Rouwenhorst 2008; Fama & French 1987). The non-linear relationship of inventories to Convenience Yield is shown in *Figure 15*.

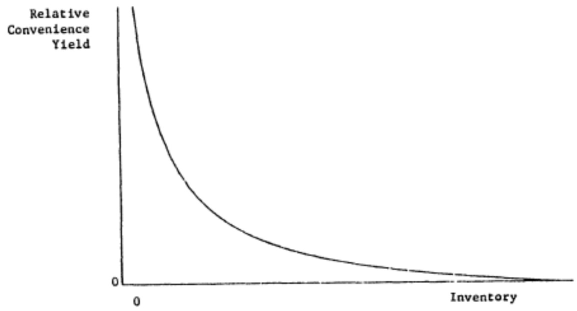


Figure 15: The Relative Convenience Yield (risk premium) as a function of Inventory (from Fama & French 1988)

While risk premiums may be higher at low inventories, futures prices are more stable than associated spots under such circumstances, in accordance with the Samuelson hypothesis (Fama & French 1988). Inventories are expected to be low during peaks in the business cycle, and higher at other times. Fama & French (1988) found that metal production, for example, can be especially vulnerable to sudden demand shocks during an economic boom, and are therefore unable to adapt quickly to such market changes. As such, inventories will normally fall as production takes time to ramp-up to meet the new market conditions, meaning forward prices are generally below spot prices and spots are more volatile than futures. This too is predicted by the theory of storage. Despite some issues with measurement errors, Gorton, Hayashi & Rouwenhorst (2008) empirically found that “prior futures returns, prior spot price changes and the futures basis are correlated with futures risk premiums as predicted by the Theory”.

5.2.2 Theory of Normal Backwardation

Classically it is thought that the current price of a futures contract “equals the market consensus expectation of the spot price on the delivery date” (Chang 1985). However, Keynes’ and Hicks’ *Theory of Normal Backwardation* states that two major roles of futures markets, i.e. that they facilitate hedging while at the same time providing a publicly known future value for a commodity, are incompatible with each other (ibid.). In such a way, they rejected the idea that the futures price is a good reflection of the future spot price, because “the quoted forward price, though above [below] the present spot value, must fall below [or rise above] the anticipated future spot price by at least the amount of the normal backwardation” (Kolb 1992).

The Theory of Normal Backwardation views futures markets as a means of transferring risk, whereby risk-averse speculators who buy long options earn a premium on the risk they take away from the producers or hedgers. In such a way, the *basis*, the difference between the current spot price at time *t*, S_t, and the future price at date *t* for delivery at time *T*, $F_{t,T}$, is given by the formula

$$F_{t,T} - S_t = [E_t(S_T) - S_t] - \pi_{t,T}(I)$$

where $E_t(S_T)$ is the expected future spot price at time *t* with maturity *T* and $\pi_{t,T}(I)$ is the risk premium as a function of inventory. Therefore the *basis* of futures markets consists of two components; the expected difference in spot prices and the risk premium (Gorton & Rouwenhorst 2005).

Keynes argued that the long (or short) speculator will gain the risk premium only by purchasing from the short (or long) hedger at a price below (above) the expected futures price. This theory is based on three main assumptions; that speculators are risk averse, they hold net long positions and are unable to forecast future prices (Chang 1985). In so doing, Keynes asserted that risk premiums would generally accrue to the holders of long positions (Gorton & Rouwenhorst 2005). Gorton and Rouwenhorst (2005) give an example of this by imagining a grain producer who sells grain futures to guarantee the future price of his crop, thus insuring against market fluctuations by the time of harvest (and maturity of the futures contract). Hence speculators provide insurance by buying these grain futures, but the future price they offer will be less than the expected future spot price, and the difference is related to the risk premium.

Keynes and Hicks thought of the risk premium as being “the outcome of the supply and demand for long and short positions in the futures markets” and termed this ‘hedging pressure’ (Gorton, Hayashi & Rouwenhorst 2008). In other words, if demand from short hedgers is higher than the supply of long speculators, there will be a positive risk premium (ibid.).

Numerous studies have attempted to verify this theory, with no consensus regarding its validity (Bryant, Bessler & Haigh 2006). Fama & French (1987) and Chang (1985) all found reasonable agreement between experiment and the theory of normal backwardation, with Chang going so far as to blame the absence of consistent evidence on either poor assumptions or "lack of sound statistical procedures". Gorton, Hayashi & Rouwenhorst (2008), on the other hand, found no evidence in support of the theory of 'hedging pressure', but rather found that risk premiums were related with inventories as predicted by the theory of storage. Bryant, Bessler & Haigh (2006) point out two logical reasons why this theory cannot be emphatically proven or rejected; first, it is impossible to observe *projected future spot prices*, and therefore any risk premium, until the future spot becomes the actual spot. Secondly they claim that it is not feasible for researchers to seek the answer to this question by experimentation [because] systematic manipulation of futures markets is not only impractical, it is also illegal."

5.3 Efficient Market Hypothesis

During the decades leading up to the current crisis, the Efficient Market Hypothesis (EMH) was the dominant view of the way markets work (Cohen 2012). The hypothesis, first expounded by Eugene Fama (1970), is that in an Efficient Market, prices 'fully reflect' all available information. Some critical assumptions to reach that idea were that market actors act rationally, evaluate all assets and decisions based on fundamentals alone (i.e. supply and demand), that these evaluations take into account all public, and some private, information, that there is no collusion in the market and that excessive returns are impossible as they will be arbitraged away (UNCTAD 2011; Otto 2011). Further to these definitions, the EMH is also associated with the idea of a 'random walk', whereby all price fluctuations move independently of each other. In other words, "the flow of information is unimpeded and information is immediately reflected in stock prices, [so] tomorrow's price change will reflect only tomorrow's news and will be independent of the price changes today" (Malkiel 2003).

Many tests have been performed on the EMH, although two techniques are generally used, the so-called 'unbiasedness hypothesis' and the 'speculative efficiency hypothesis'. The fundamental idea of both is that, under the conditions laid out above, the futures price is the best available indicator of the future spot price and the overall expected rate of return to speculators in futures will be zero (Otto 2011). This has profound implications for regulators and speculators. As the EMH was widely accepted, regulators considered it their duty to ensure accounting standards and disclosure of data, but no more (Cohen 2012). Meanwhile, speculators were seen as being unable to influence prices, as if they did, consumers would move elsewhere (UNCTAD 2011). An example repeated by UNCTAD (2011) shows that economists have used the lack of evident increases in inventories around the sharp oil price increases of 2007-2008 to argue against speculation playing a role, because under EMH overall speculative returns are zero.

Otto (2011) tested the speculative efficiency of metals on the LME, and found that, with the exception of aluminium, no markets could be called efficient. In correspondence, Otto (2012) added that aluminium markets show reasonable efficiency as they have "always been in contango in the short term period, so some arbitrage should have increased market efficiency". Otto (2012) asserts that copper, on the other hand, is normally in backwardation and its susceptibility to shocks made it difficult to define an efficient trading strategy. Otto's (2011) results actually run contrary to many preceding studies, a phenomenon attributed by the author to either the similarities of trading strategies for 3-month and 15-month futures (thus they experience very similar patterns), or to the increasing use of the LME's electronic trading platform, LME Select.

UNCTAD (2011) offers further rationale for the breakdown of the EMH on commodities markets. As there exist in these markets a large number of counterparties holding sizeable positions, those positions may be less than perfectly elastic. Therefore large orders may encounter "short-term liquidity constraints and cause significant price shifts" (ibid.). What is more, a large percentage of uninformed [such as algorithmic] traders may react similarly to the same information, and thus overly increase the effect of this information, therefore collectively generating "the trends that they then individually identify and follow" (ibid.). As UNCTAD points out, the increase in index and especially algorithmic traders could "result in increased short-term price volatility, as well as the overshooting of price peaks and troughs". This herd behaviour is analysed more thoroughly in the following sub-section.

5.3.1 Herd Behaviour and bubble formation in Commodities Markets

Herd behaviour involves trading by agents who follow the trend in past market movements, even though other information may suggest a contrary strategy (Avery & Zemsky 1998). Identifying herd behaviour in financial markets is important as it offers possible explanations for price bubbles and excess volatility (ibid.). Brunnermeier, quoted in Irwin & Sanders (2011) defines a bubble as "asset prices that exceed an asset's fundamental value because [the] current owners believe that they can resell the asset at an even higher price in the future". This type of behaviour can be found in situations of uncertainty, where less informed traders will follow the group in order not to be considered responsible for incurred losses. Should a trader lose by following the market, they are able to argue that it was market conditions, rather than personal misjudgement, that were to blame, whereas a trader that loses by going against the market could be considered personally liable (UNCTAD 2011).

Conditions for herd behaviour are commonplace, not least because market conditions are always uncertain. Due to delays in production – inherent in fuel and metal commodities although absent from equities markets – to meet new market conditions, inventories will always be in a state of flux and therefore vulnerable to stock-outs, leading to increased volatility in spot prices (as shown above) (Gorton, Hayashi & Rouwenhorst 2008). Because of expected increases in risk premiums, a shock will cause many actors to overreact to the news and invest in the commodity, thus increasing the size of the peak through momentum (UNCTAD 2011; Gorton, Hayashi & Rouwenhorst 2008). The resulting 'information cascade' results in a breakdown of social learning as traders make the same choices, revealing no new information, but rather building on previous data (Avery & Zemsky 1998). These information cascades occur when actors are unequally informed, and benefits disproportionally accrue to those who make decisions early (UNCTAD 2011). Furthermore, the difficulty in distinguishing between informed and uniformed (or herd) traders leads to the presupposition that most traders possess accurate information (Avery and Zemsky 1998; UNCTAD 2011).

Avery & Zemsky (1998) suggest that the plethora of papers on herding "recalls a once-prominent view of asset markets as driven by 'animal spirits,' where investors behave like imitative lemmings." Writing at the time, the rational actors approach implied by the EMH provided the dominant mind-set for economists, although they admit that "both market participants and financial economists reportedly still believe[d] that imitative behavior is widespread in financial markets" (ibid.). Nonetheless, even within the EMH there are grounds for herding behaviour depending on 'dimensions of uncertainty'. Should only one dimension exist, the *effect* of a shock, prices should adjust to prohibit herding. With a further dimension, the *existence* of a genuine shock, herding may arise although the amount of price distortion would be limited by identification of informed and uninformed traders. However, when that distinction between informed and uninformed trades is not available, a third dimension can be added regarding the quality of information, at which point Avery & Zemsky (1998) admit that "herd behavior can lead to a significant, short-run mispricing".

Using general theoretical models based on the EMH and presuming rational actors and prices which incorporate all available public information, Avery and Zemsky (1998) showed that volatility which exceeds supply-demand fundamentals is impossible, while price bubbles couldn't be both likely *and* extreme. Gilbert (2010), on the other hand, looked for herd behaviour in actual market data, under the premise that trends will be exaggerated where herding exists. Looking at both monthly and intra-day data for a number of commodities, Gilbert (2010) found that trend-following was most pronounced in copper traded on the LME. Monthly data analysis revealed a substantial price bubble around the middle of 2006 (the area above the dashed line seen in the left-hand graph of *Figure 16*), while daily data showed three periods of bubble formation, in 2004, 2005 and 2008 (the red areas shown on the right-hand graph of *Figure 16*) – the last of which was a negative bubble spanning the end of the available data.

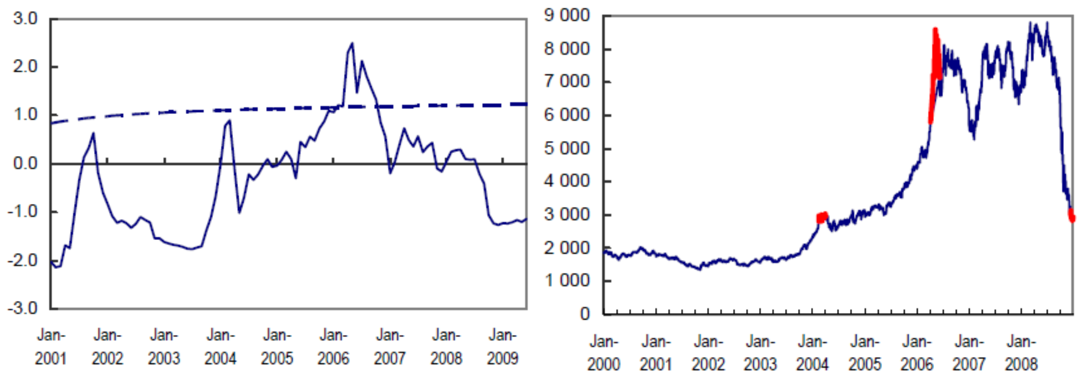


Figure 16: Left graph shows the first order Augmented Dickey-Fuller regression for LME copper using monthly price data from the International Monetary Fund (IMF 2012) – the bubble can be seen above the dashed line: The right graph shows three periods (in red) of bubble behaviour, using daily LME data (y-axis is in US$/ton)

The basic techniques used by Gilbert (2010) are explained in more detail in the Section 6.6, but he adds to his analysis by pointing out that the technique can identify only the tail-end of a financial bubble, as on the three occasions when bubbles were identified there had been long-term pricing trends prior to identification (in the case of the 2004 and 2006 bubbles, prices had been rising significantly for at least a year beforehand, whereas the 2008 bubble followed three months of severe price drops). A simplified version of Gilbert's experiment was carried out for the purposes of this paper and largely reflects his findings (Section 6.7.1)

5.3.2 Critique of Bubble Formation Arguments

The subject of herding behaviour and bubble formation in commodities markets has met with much criticism, with the IMF (2010) (quoted in Tilton, Humphreys & Radetzki 2011) continuing to assert that ''there remains little evidence that financial investment has a significant sustained impact on commodity prices above and beyond current and expected supply-demand fundamentals.'' Irwin & Sanders (2010), amongst others, set out some logical and practical inconsistencies associated with bubble formation, especially in regard to commodity indices. Firstly they point out that the increased influx of money to commodities markets seen in the last few years does not necessarily equate with increased demand (Irwin, Sanders & Merrin 2009). Under EMH, there is "no limit to the number of futures contracts that can be created at a given price level" (Irwin & Sanders 2010). What is more, even accounting for more realistic market conditions, the trades of uninformed actors can only impact prices if the trades are believed to be 'informed' by a large number of other participants, although just what effect AT and HFT has on this situation is hard to judge. Irwin & Sanders (2010) state that it "would have required a large number of sophisticated and experienced traders in commodity futures markets to reach a conclusion that index fund [or other] investors possessed valuable information that they themselves did not possess" (ibid.). This inconsistency is valid as long as price setting depends primarily on informed traders. However the recent increase in algorithmic trading, index funds and other non-traditional parties means 'informed actors' are now in the minority on many commodity exchanges, thus increasing the possibility for herd behaviour.

Secondly, Irwin & Sanders (2010) argue that investors such as index funds, which trade only in futures, cannot have influenced both the futures *and* spot price. They claim that as there is no actual physical delivery or 'hording' of the cash commodity associated with these trades, it is not possible to influence the spot price of commodities. However Tilton, Humphreys & Radetzki (2011) counter this by asserting that investor (i.e. futures) demand *can* drive prices higher irrespective of physical stocks because of certain fundamental properties of the *investor demand curve*, while Hernandez and Torero (2010) empirically show that the futures price for commodities *does* has a driving effect on spots, not least because price *should* always converge as maturity of the futures contract approaches. The argument also seems to ignore the influence of ETFs which *do* hold physical stock.

6. Case Study: LME Copper

6.1 Introduction

Chapter 6 of this master's thesis takes the topic away from the general discussion of the previous sections to look in depth at the market behaviour of Grade-A copper traded on the London Metal Exchange (LME). Taking into account the Theoretical Framework, above, the first part of this section will deal with the background of copper as a vital global resource and as a highly-traded commodity on commodities exchanges, of which the LME is the world leader and benchmark price-setter for non-ferrous metals such as copper. Following that discussion, sub-sections 6.5 – 6.7 will use econometric tests on market data to investigate whether the Efficient Market Hypothesis is a valid approximation for LME copper, and whether market manipulation or the effects of speculation can be observed.

6.2 Motivation

As mentioned in Section 1.3, the choice of copper traded on the LME to form my case study is guided by my own experiences of trading in that market. Although I was not trading on the exchange itself, I did witness the value of daily closing prices of copper in global price-setting of the commodity, whereby quotations would be given for LME minus a certain figure, depending on the grade of scrap being traded. I also witnessed first-hand the effects of large daily price fluctuations on business and planning, and am therefore interested in ascertaining reasons behind these inexplicable movements.

6.3 Background

While, from a financial economics perspective it is interesting to look purely at the market behaviour of copper, as this thesis concerns Sustainable Development it must naturally take a broader look at this commodity. Therefore this sub-section will look at the history of copper as a resource, including a consideration of what economists call the fundamentals (production and demand), before also looking at a history of the LME and going on to price progressions of the commodity.

6.3.1 Copper

Copper is one of the most highly traded and economically important metals on Earth. Its properties have long been appreciated, as has the ease at which it can be refined. Evidence for copper smelting has been found across continents, dating from around 5000BC. At that time, easily-identifiable green nuggets of copper carbonate were smelted to produce weapons, tools and jewellery. Later it was discovered that by adding tin to the molten copper, bronze could be formed, producing a much more suitable metal for knives and swords, and giving rise to the period known as the bronze age (approximately 3000BC to 1000BC) (Emsley 2001).

Copper's use in economic development is unparalleled, due to its high conductivity of both electricity and heat, as well as durability under severe weather conditions. Today it is used in electrical equipment (60%); construction, especially in roofing and plumbing (20%) and heat exchangers (15%). Combined with 10% nickel, copper is highly resistant to corrosion from sea water, and therefore is the metal of choice for marine pumps and propellers used in desalination plants (Emsley 2001) or wave turbines.

As economies have developed, especially in Asia, demand for copper, satisfied by increased mine production, has risen sharply. In 2010 almost 20 million tons of the metal were extracted worldwide – nearly double the figure of just 20 years previously (see *Figure 17*). Chile remains the single largest producer in the world, although since 2004 Chilean mine production has levelled-off to approximately 6 million tonnes per year. The United States, formerly a major copper extractor, has seen copper production fall steadily since the end of the 1990s. This could imply a peak in US copper production. In its place, China has ramped-up extraction (although it remains at less than a quarter of that of Chile), while new mines in Peru and Indonesia have helped to meet the unprecedented demand for the metal.

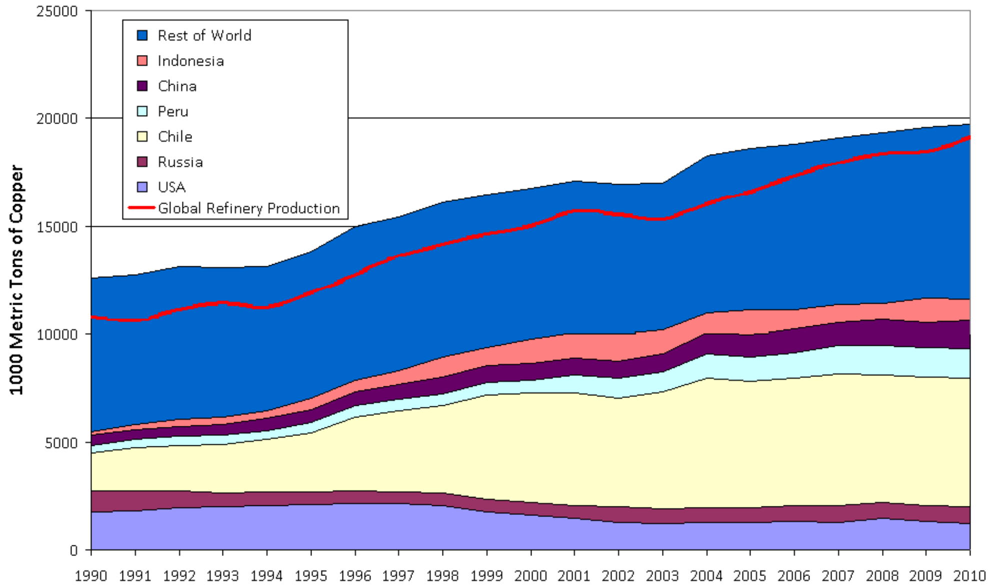


Figure 17: Global mine and refinery (red line) production from 1990-2010
(data from CDA 2011 and Edelstein 2010)

The Copper Development Association (CDA 2012) estimates that 700 billion pounds (320 million metric tons) has been extracted from the Earth over the course of human history, which is a surprisingly small estimate given that their own data (CDA 2011) estimates that 295 million tonnes has been extracted since 1990. Nevertheless, this remains a small figure when compared with estimated global reserves of between 690 and 3000 million tonnes (USGS 2012). Despite much talk of 'peak copper', the metal is highly recyclable, with end of life recycling rates of well over 50% and the annual contribution of secondary input to primary copper production of around 35% - a ratio which has remained fairly constant in the last ten years despite a huge increase in primary production (UNEP 2011; ISCG 2010)

6.3.2 The London Metal Exchange

Metals have been traded in London since at least the time of Queen Elizabeth I, with the first identifiable date being the opening of the Royal Exchange in 1571. As the popularity of the exchange grew, on the back of increased trade to power the world's largest empire and the inability of domestic production to keep pace with development, it became increasingly difficult to trade on the general exchange. From the early 19th century, merchants started trading various commodities in the coffeehouses around the Royal Exchange. It was in the Jerusalem Coffee House that traders started drawing circles in the sawdust to draw together interested parties, and the tradition of the *Ring* was born here (LME.com 2012).

Aided by advances in communications technology, both in the form of the telegraph and the opening of the Suez canal in 1869, it became easier and more necessary for metals traders to have their own exchange, and the London Metals Exchange took on its current form in 1877 (Northedge 2007). The ownership structure still retains the essence of its founding ideals – the exchange operates like a co-operative, whereby the traders are also the owners of the company (Thomas 2011). The 12 largest traders form the modern day *Ring*, are the major shareholders in the newly formed LME Holdings Ltd. and are allowed to issue LME contracts and to provide clearing. At the time of writing the ring comprises a number of large financial institutions (including Barclays Bank, JP Morgan and Société Générale), as well as some major metals trading companies (LME.com1 2012). It should be mentioned that the derivatives broker MF Global was one of the 12 ring members until November 2011 when it filed for bankruptcy following losses in the bond market (Leising 2011). Its 4.7% stake in the LME was bought by JP Morgan for just over £40 per share (Farchy 2011A).

Today, the LME is a unique exchange, combining a futures market with a physical forward market (it trades both electronic and physical stocks) (Thomas 2011). It is the last open outcry market in the City of London – although since 2001 trading on the LME's electronic platform, LME Select, has increased hugely – and is generally seen as the benchmark price setting exchange for global non-ferrous (or base) metals (Northedge 2007). Indeed, the exchange holds 80% of the market share in global trading of base metals, and in 2009 saw the equivalent of US$7.41 trillion traded in a single year (equivalent to US$29 billion per day) (Abbott 2011; Daily Telegraph 2010). However, despite these huge numbers, the LME remains virtually a non-profit enterprise – in 2009 profits were a mere £13.56 million (US$21.8 million), against revenues of £43.59 million (Thomas 2011).

Despite the meagre revenues emanating from the exchange, in June 2012 the LME was sold to the Hong Kong Stock Exchange for £1.4 billion (US$2.15 billion), after many years of speculation as to the independent future of the LME. The deal is expected to help the LME to break into the Chinese market and compete more easily with its major challenger, the Shanghai Futures Exchange, although it will most likely also lead to the disbanding of the unique open outcry trading system in 2015 (Thomas & Thomas 2012).

6.3.3 Copper as a traded commodity

Copper was one of the original metals traded on the LME at its inception in 1877 and, barring a 14-year period from 1939, has been traded almost continuously since (Northedge 2007). Today copper futures are the second most traded metal contracts on the LME (after aluminium), accounting for a quarter of futures trading volumes and a half of all options trades made on the exchange in the year to June 2012 (LME.com2). Copper is also a constituent of the major commodities indexes (see Section 3.4.2) accounting for 3.45% of the component weight of the S&P GSCI (goldmansachs.com 2012) and 7.5% of the DJ-UBS CI (Dow Jones Indexes 2012).

Price evolution of the Grade A copper spot contract, from January 2001, can be seen in *Figure 18*, alongside stocks and demand statistics. Longer-term price graphs (1980-2012) are provided in subsequent sub-sections. During the period 2004-2006, prices jumped from under US$2000 per tonne to over US$8000 per tonne. Except for the period at the end of 2008 which coincides with the Credit Crunch, copper prices have remained at that higher level ever since. There is an interesting dynamic between the stocks of copper held by various parties and the spot price of the commodity. It appears self-evident that the reduction in stocks held by exchanges during the period 2002-2004 had an influence on the increase in copper prices, although the large time lag between the depletion of exchange inventories (stocks) and the first price peak in early 2006 suggests that this was not the single, overriding cause of the price hike. The Theory of Storage (see Section 5.2.1) does not explicitly link absolute prices with stocks, but does imply that the convenience yields (or profits) should be higher as inventories become smaller.

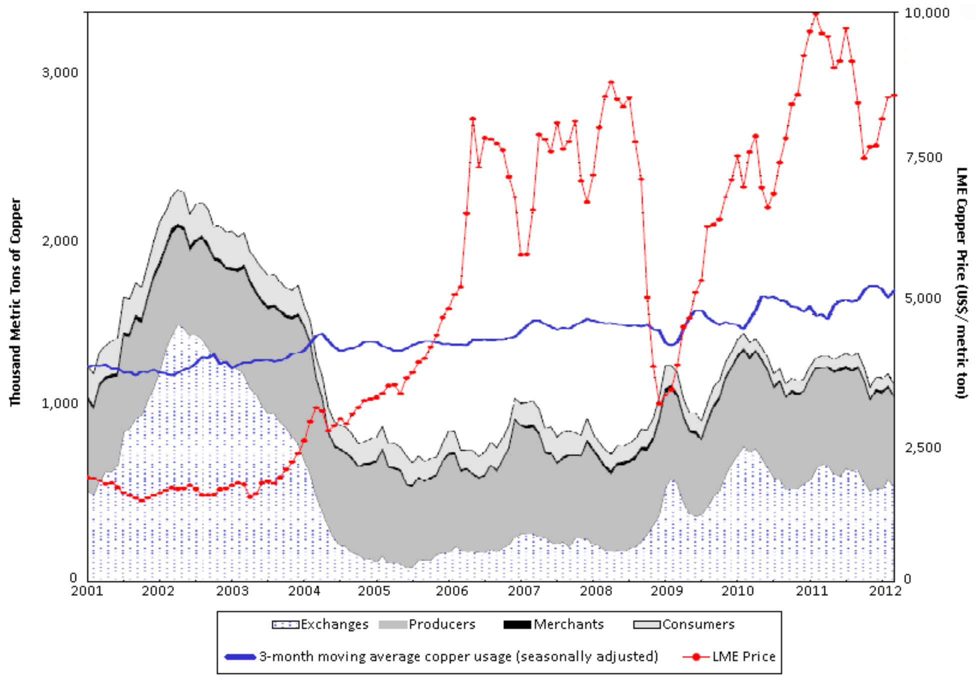


Figure 18: LME spot copper price (red line) against volumes held by various parties and a seasonally adjusted moving average of copper usage (ICSG 2012)

Possibly more interesting, especially for considering the effects of financial speculation on prices, are the stock spikes seen in 2007, 2009 and 2010, which corresponded with troughs in the global copper price. In 2007 it was largely producers holding stock that coincided with the dip in price. Causally it is more logical that stock-holding took place in anticipation of a return to previous price levels – and indeed could have contributed to the restoration of prices in the US$8000/tonne mark, rather than being a cause of the price drop. Stockholding, leading to constrained supply, should push prices up rather than down. The other two peak/trough coincidences appear different, however. In both 2009 and 2010 it was the exchanges which held most of the excess stocks. Presumably the lower price levels were seen as an opportunity to buy cheaply in anticipation of easy profits when the price returned, as indeed it did. While producers, consumers and merchants are constrained by the physical difficulties in altering production/demand, or storing the physical commodity, highly liquid exchange traders can generally afford to hold the commodity for a number of months while waiting for a resumption of previous price levels. Nonetheless, this stockholding could have had the same effect on prices as that of the producers – a constraint in supply should lead to increased market prices.

6.4 Data

In order to perform tests to ascertain the effects of speculation on LME copper, it was important to have access to market data. Two levels of data are used in this section; one at a monthly and one at the daily level. Monthly price data was provided by the IMF (2012) while daily closing spots and 3-month futures prices were kindly provided by Professor Christopher Gilbert of the University of Treno. The available data spans the period January 1980 to January 2012, giving a reasonable number of data points. An extrapolation of the daily data was used to produce the graph of weekly LME copper prices for both spot and 3-month futures contracts shown below.

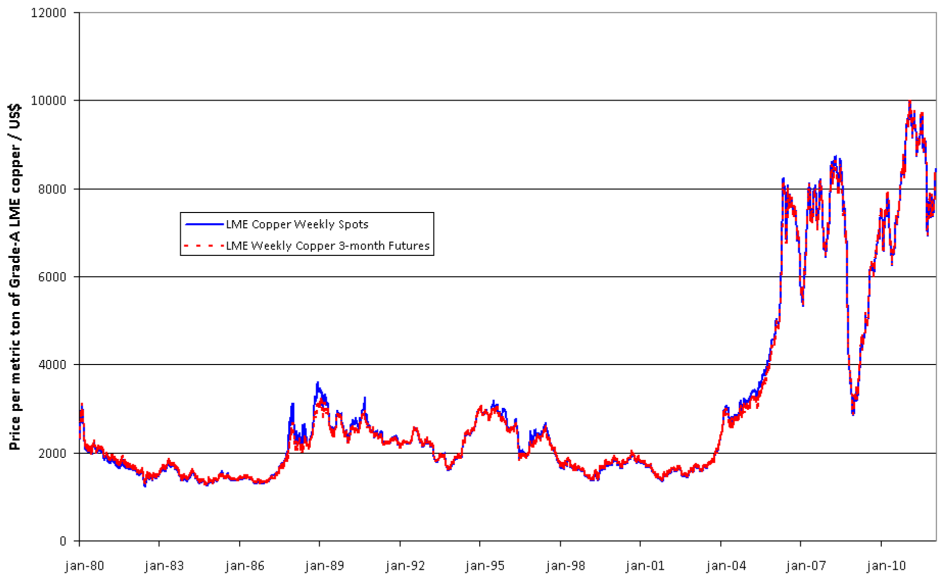


Figure 19: Weekly spots (blue line) and 3-month futures (dotted red line) prices for LME Grade A Copper Sellers.

As would be expected, spots and futures prices are closely correlated, with equal reactions to shocks. The causal relationship between spots and futures prices is covered further in Sections 6.6 and 6.7. Closer examination of the above chart yields some interesting price reactions to events. The first small spike occurs towards the end of 1987, in the October of which the Dow Jones Industrial Average dropped by 22.6% on a single day – the largest one-day percentage drop in its history. The global stock market crash was not confined to the United States however, and became known as Black Monday (Browning 2007). The steady rise during 1995 mirrors that of the NASDAQ index, which prompted then-chairman of the Federal Reserve Board, Alan Greenspan, to coin the phrase 'irrational exuberance' in reference to the stock market bubble which was then starting to build towards the dot.com crash of 2000 (Phillips, Wu & Yu 2009). Finally, the major fall seen between July and December 2008 was almost certainly linked to the sub-prime financial crisis – Lehman brothers went out of business on 15 September 2008, in the middle of this price collapse (Federal Reserve Bank of St Louis 2012), possibly due in part to exposure to commodities indexes.

6.5 Preliminary tests

The brief historical analysis shown above is not sufficient to prove (or otherwise) the influence of excessive speculation on copper prices, therefore more robust tests are required. The following sections will detail two econometric methods for searching for breakdowns in the Efficient Market Hypothesis, and thus infer irrational (speculative) market behaviour. However, some simple, preliminary statistical analysis is also useful for investigating irrational commodity market behaviour.

6.5.1 Cointegration

One of the major observations outlined in section 3.3 of this report is the increased cointegration of price fluctuations in markets under 'economic stress'. *Figure 3* shows the results of an experiment performed by Basu and Gavin (2011) linking correlation coefficients of the S&P GSCI (see Section 3.4.2) and the price of West Texas Intermediate (WTI) Crude Oil. *Figure 20* shows a similar experiment performed with spot prices of LME Grade A copper and the FTSE 100 share index from January 2001 to February 2012. Early in the decade there is no obvious correlation between the two plots. This is to be expected as the FTSE 100 and

LME copper would not normally be considered to have a causal relationship in fluctuations. However, after the crash of 2008 the cointegration of price fluctuations becomes much more visible. Upon close inspection the upper log-plot of these values shows equivalent fluctuations between the two indicators. *Figure 21* shows a similar plot for normalised values of the S&P GSCI Multiple contract, the FTSE 100 and Grade A LME copper spots. The co-movement of these three values is striking, and implies a strong financial impact on the fluctuations of commodity prices.

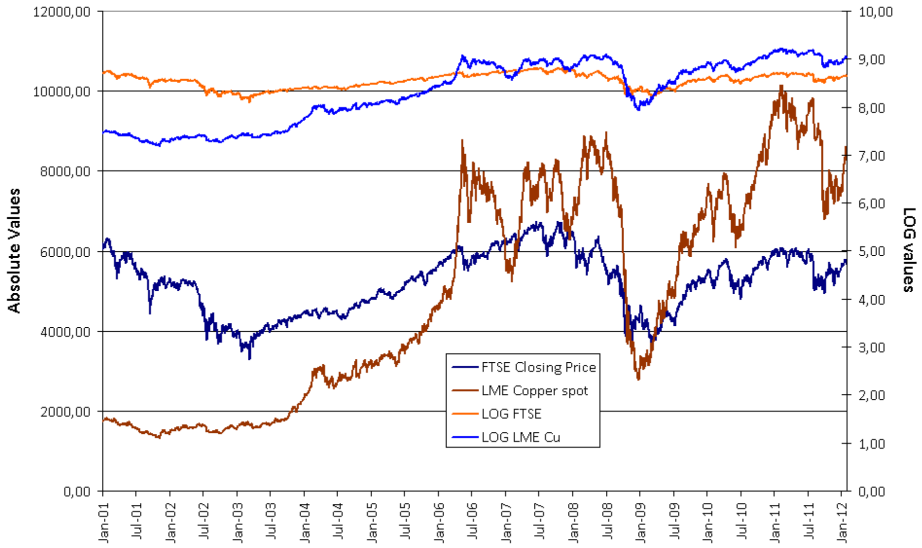


Figure 20: Comparison of FTSE 100 daily closing values and daily LME copper grade A spot prices for the period January 2001 to January 2012. The upper log plots show more clearly the post-crash co-integration of price fluctuations.

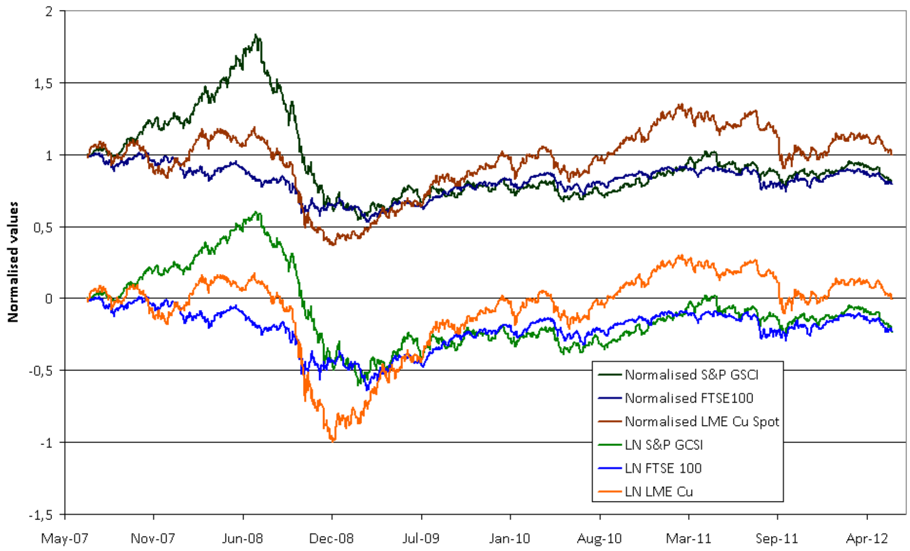


Figure 21: Comparison of normalised daily end quotes for the S&P GS Commodity Index, the FTSE100 index and the LME Grade A spot price. The upper plot shows normalised prices, and the lower lines are the natural logs of those values.

A number of studies have investigated the phenomenon shown in *Figure 21*. Büyükşahin & Robe (2010) likewise found no obvious increase in commodity-equity correlations until the Autumn of 2008, but they observed this correlation on multiple data frequencies (daily and weekly) and between a number of commodities and indices. They blame the correlations on financial stress, and show that correlation increases with market stress. While Tang & Xiong (2011) equate this increased correlation with the explosion in commodity indices, Büyükşahin & Robe (2010) prefer to look at the role of Hedge Funds in producing cointegrated commodities and equities markets. Many papers make the point that commodity derivatives have (mistakenly) become vehicles to hedge equities risk due to a perception that the two are *inversely* related to each other (Basu & Gavin 2011) – the above two graphs however appear to show that the opposite is currently true, that in fact commodities and equities prices are *directly* related. However, in order to make more concrete statements on the problem, more thorough analysis is required. Granger-causality tests between the FTSE100 equities index and 3-month LME copper futures are examined later in this section.

6.5.2 Statistical Analysis

A further test for changes in market dynamics can be seen by comparing fluctuations of daily returns over certain periods. Returns, r_t, are used because of the non-stationarity of market prices and therefore often give a more accurate impression of market behaviour. They are calculated using the formula given in Bekiros & Diks (2008), such that

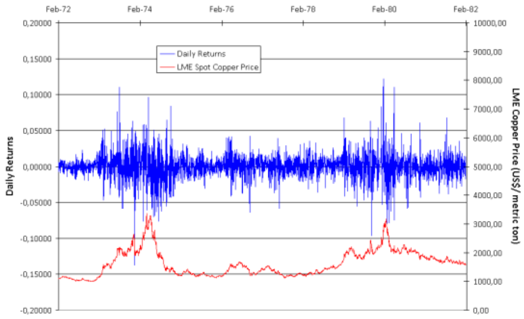
$$r_t = \ln(P_t) - \ln(P_{t-1})$$

where P_t is the price at time t and P_{t-1} is the price at $t-1$ (in this case the previous day). Tests were performed over four 10-year periods (referred to as regimes) for spot prices, and 3 such periods for daily 3-month futures data. The results are shown in *Figure 22*.

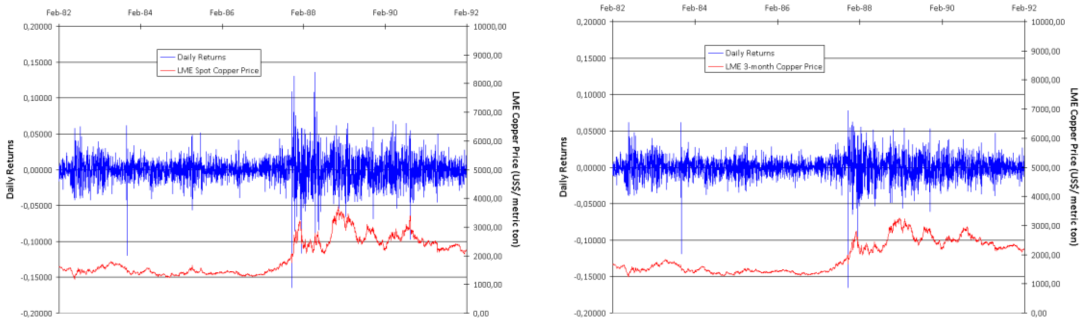
The most striking observation from the graphs is that fluctuations in daily returns increase (both positively and negatively) around times of major price changes, whether up or down. The regimes were then subjected to a basic statistical analysis, and the results are shown in *Table 2*. One further regime was investigated for the period 10 May 2006 (the first time the price broke US$8000/tonne) to 31 January 2012 (US$8485/tonne) to coincide with the new price levels above US$8000/tonne and is referred to as Regime 3A. This was done in order to try and offset the bias due to the exceptional price increases seen between 2004-2006.

Regime	Mean	Standard Deviation	Variance	Kurtosis	Skewness
Spot 0	0,000160	0,018137	0,000329	5,423847	-0,058143
Spot 1	0,000121	0,018828	0,000354	6,959076	-0,117668
Spot 2	-0,000151	0,014967	0,000224	9,010785	0,002437
Spot 3	0,000683	0,019389	0,000376	2,570959	-0,216595
Spot 3A	0,000057	0,022402	0,000502	1,815115	-0,201526
3-month 1	0,000110	0,015285	0,000234	8,486820	-0,746155
3-month 2	-0,000146	0,013021	0,000170	5,425508	-0,307720
3-month 3	0,000677	0,019036	0,000362	3,027409	-0,286688
3-month 3A	0,000070	0,022335	0,000499	2,035622	-0,227977

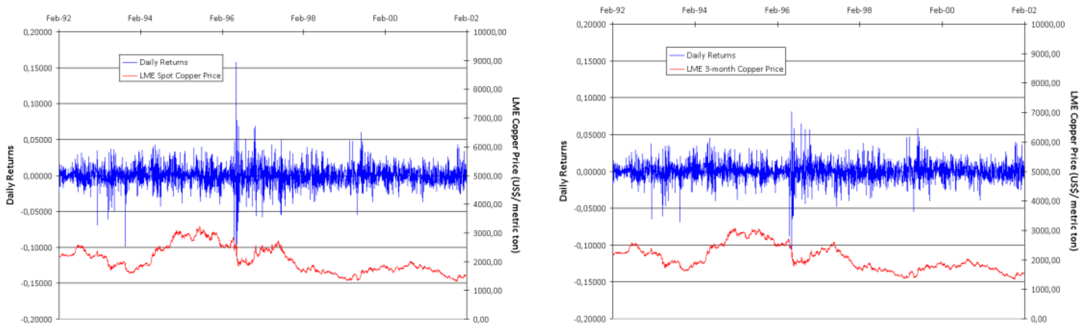
Table 2: Basic statistical analysis of daily returns from LME Copper spots and 3-month futures contracts. The regimes are explained in *Figure 22*



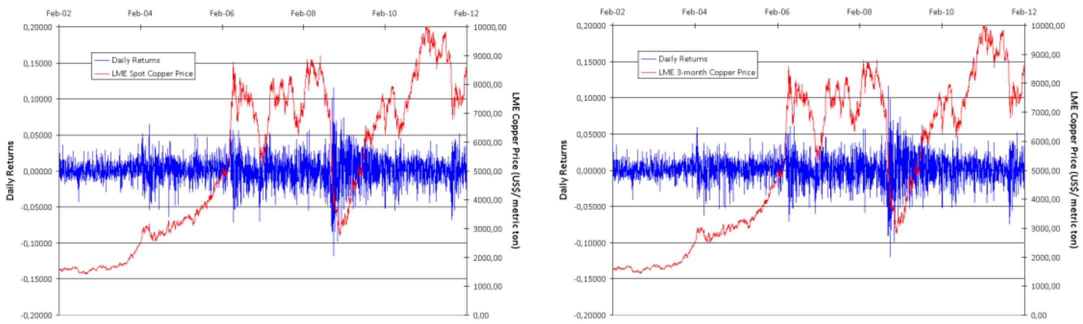
Above: Regime 0 (Feb 1972-Jan 1982); Spot price



Above: Regime 1 (Feb 1982-Jan 1992); Left, Spot price, Right, 3-month future price



Above: Regime 2 (Feb 1992-Jan 2002); Left, Spot price, Right, 3-month future price



Above: Regime 3 (Feb 2002-Jan 2012); Left, Spot price, Right, 3-month future price

Figure 22: Daily returns (blue line) for LME Grade A Copper Spot prices (left) and 3-month futures (right) across various regimes, as detailed above. The red lines show real-time price fluctuation of the applicable contract.

The mean daily return should reflect the overall change in price seen over the period studied, and therefore the huge increases in means between Regimes 2 and 3 (present in both spots and futures) should not come as a surprise. Regime 3A was investigated to account for this overall difference, and indeed the mean for that period is significantly smaller than during any other 10-year period. It is the other findings, therefore, that are of more interest. The results mirror those of WTI oil contracts tested by Bekiros & Diks (2008), whereby the latter period sees both higher variance and a higher dispersion of returns reflected in lower kurtosis. The kurtosis measures the 'peakedness' of a distribution and is referred to as the 'volatility of volatility,' used by analysts to assess the probability of extreme losses or returns in the future. A kurtosis score of 3 implies the Normal distribution, while numbers above 3 suggest a more 'pointed' distribution and under 3 a more 'rounded' one (Investopedia 2012). For the purposes of further investigation, a normal distribution is assumed – a reasonable approximation, especially for later regimes. The larger negative skewness reflects the increased frequency of large negative spikes (Bekiros & Diks 2008). Indeed, according to financial theory, a large negative skew implies frequent small gains and a few extreme losses (Investopedia, 2012), which is probably what could be expected from looking at the daily price graph. Interestingly, the skewness of futures and spots returns seem to be converging. While the 3-month skew was historically larger (more negative) than for spots, that no longer appears to be true.

6.5.3 Volatility

While the above multi-year analysis can give an idea of trends and help to separate different regimes, it is also interesting to investigate standard deviation (a measurement of volatility) of monthly data, plotted against equivalent monthly price graphs. Following the techniques used by Hernandez & Torero (2010), monthly settlement (or spot) price data (in green) was compared with the standard deviation of the 21 daily prices or returns leading up to the end of the month. These 21 data points approximate to the month in question, although in certain cases they may represent more (or fewer) days than just that month's data. The results of these tests can be seen in *Figure 23*.

Standard deviation represents the risk of investing in a certain commodity. Overall, risk is seen as being strongly correlated with expected premiums, so investors would expect to see higher returns on their investment as risk increases (Hedge Funds Consistency Index 2012). As observed by Hernandez & Torero (2010), the volatility in both spots and 3-month futures prices is highly correlated. Spot prices are expected to be more volatile than futures, and this small difference is shown in both *Figure 23* and *Table 2*. Interestingly, as with the kurtosis and skewness of the different contract returns, the standard deviation appears to be converging as well.

Inspection of the graphs clearly shows the volatility caused by the shock of 1987's Black Monday as well as the stock bubble of late 1996. This result is also seen in work by Hernandez & Torero (2010) on agricultural commodities. Although data used by Hernandez & Torero (2010) only goes back to 1994, the spikes seen in volatility of both prices and returns in July 1996 is strongly mirrored in Corn (*Figure 24 Upper*) and lesser so in Soybeans. As detailed in Section 6.4, it was during this period that Alan Greenspan observed 'irrational exuberance' in the NASDAQ, and this financial bubble seems to have influenced the volatility of both copper and corn. This would seem to imply financial influence in commodities prices, and subsequent cointegration of volatility, some years before the commodity financialisation of the 2000s (Section 3.3). While both prices and returns on LME copper show similar volatility reactions to the events of 1987 and 1996, the recent financial crisis shows some marked differences. Volatility in prices appears to have peaked three times since 2006 – once in May 2006, again in October 2008 and also in October 2011 - although returns have only peaked once, in 2008. At that point (mirrored in both Corn and Soybeans shown in *Figure 24*), the peak would seem to reflect a negative bubble which manifested itself in a rapid price collapse. At that point (and to a lesser extent in 2006 and 2011), volatility in copper futures returns was higher than that of spots, which in itself is an unusual situation.

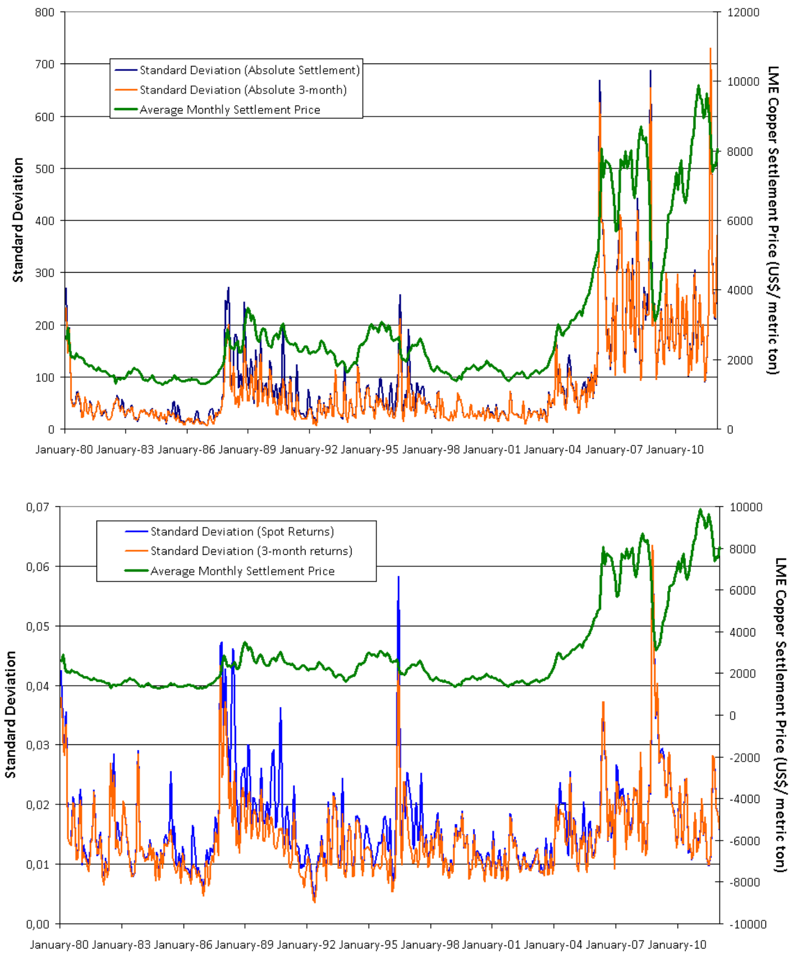


Figure 23: Standard deviations associated with spots and 3-month LME copper prices (upper plot) and with daily returns (lower plot – see Section 6.5.2 for more details on returns)

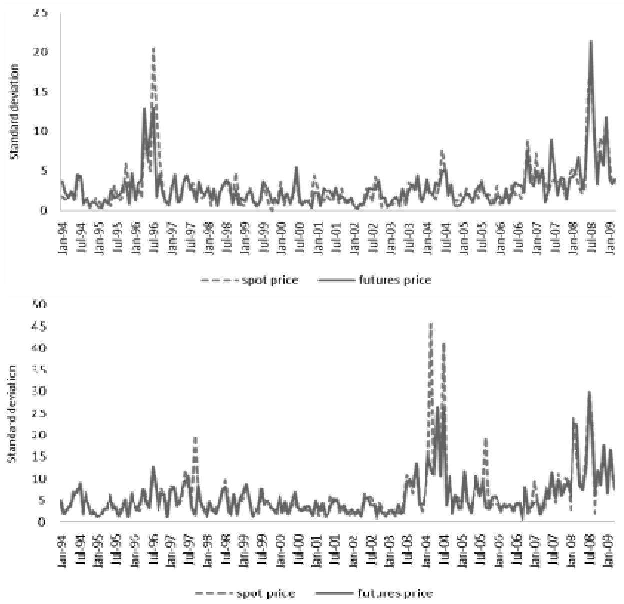


Figure 24: Standard deviations in spot (dotted line) and futures (solid line) for Corn (Upper plot – contract is CBOT US No.2 Yellow Corn) and No. 1 yellow Soybeans (lower)

6.6 Method

Econometric tests have been devised to test specific parts of the Efficient Market Hypothesis (EMH - see Section 5.3). This section will look at two such tests to search for breakdowns in the hypothesis with relation to spots and 3-month futures copper contracts traded on the LME. The first of these tests, the t-test, looks for the limits to the concept of a random walk, whereby prices will fluctuate around a (possibly trending) point. This implies that large and continuous fluctuations, as seen in price bubbles, should not be possible. The t-test therefore tests for trends which are outside a statistical probability in order to discover the presence of financial bubbles.

The second technique for investigating the breakdown of the EMH involves looking for causality between futures and spot prices, and between LME price fluctuations and those of the financial index the FTSE100. In theory, futures and spot contracts should move randomly but equally. The test therefore investigates whether futures (spots) prices are leading fluctuations in spots (futures), and then whether the FTSE100 (copper futures) leads LME 3-month copper futures (FTSE100). The method used throughout the literature is the Granger Causality test.

A note on style

In the writing of this thesis I have had to familiarise myself with econometric methods and tests, largely by reading papers on the subject. These papers assume a high-level of econometric fore-knowledge, and therefore present the tests in a very theoretical manner which is then summarised by subsequent papers using the same techniques (c.f. Gilbert (2010) and Phillips, Wu & Yu (2009)). For example, Phillips & Yu (2011) include more than 20 equations, of which it is difficult to ascertain which ones are used to produce the results shown, and their actual method is therefore very difficult to follow for anyone without a firm grounding in the subject being discussed. While the next part of this thesis incorporates econometric tests, all effort has been made to make the theories and method easy to follow for non-econometricians.

6.6.1 Searching for financial bubbles using t-tests

Although much is talked about financial bubbles in the popular press, the definition of one can sometimes appear slightly hazy. Phillips & Yu (2011) state that a common definition for financial bubbles would be "that bubble conditions arise when the price of an asset significantly exceeds the fundamental value that is determined by the discounted expected value of the cash flows that ownership of the asset can generate." While it is difficult to estimate the discounted expected cash flow values (not least because the discount rate may be subject to large differences), other properties of a financial bubble can be investigated to determine its existence. The *random walk*, or *martingale* behaviour of prices is a central tenant of the EMH. Looking for sequences that display sub-martingale or explosive behaviour, therefore, is a well-known mechanism for testing for financial bubbles (Phillips & Yu 2011).

A number of papers use various t-statistics to look for financial bubbles. Papers by both Phillips, Wu & Yu (2009) and Phillips and Yu (2011), extrapolated upon by various authors including Gilbert (2010), set out highly complicated and precise tests which time-stamp the beginning and the end of financial bubbles using various regression statistics. Having extrapolated trends in data, all these papers used *t-tests* to search for long-term deviations from expected values, and a simplified version of the test was repeated for the purposes of this master's thesis. While the following technique may not be as accurate as that expounded in the papers referred to in this paragraph, especially with reference to exact start-finish dates of bubbles, the results can be compared to the above statistical tests and previous studies to gauge their accuracy.

The t-test used in this paper compares two distributions of data to look for significant deviations between the groups. Following the technique shown in Gilbert (2010), a control group was set up against which subsequent groups of data could be compared. The control group was defined as the monthly data from 1980, and the mean and the variance of this group was ascertained using *MSExcel*. Subsequent data received the same treatment, with the 12-month mean and variance measured for every month and the 11 preceding ones. The experiment was repeated for daily data with the 21-day mean and variance, where the 21 trading days up to the end of January 1981 were used as the control group. A normal distribution is assumed for all this data, which is an assumption with some grounding (see Section 6.5.2).

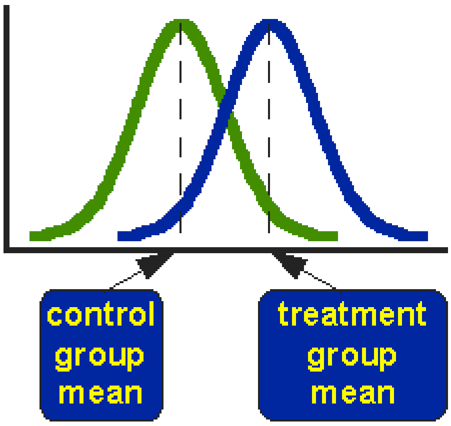


Figure 25: Comparison of two sets of normally-distributed data for the t-test (Trochim & Donnelly 2006)

Having calculated the mean and variance for each discrete group, the t-test was performed according to the following

$$t = \frac{signal}{noise} = \frac{\Delta \bar{x}_g}{\Delta \operatorname{var}_g}$$

where t is the t-statistic, $\Delta \bar{x}_g$ is the difference between means of the control and treatment groups, and Δvar_g is the standard error of the difference, given by

$$\Delta \operatorname{var}_g = SE(\bar{x}_t - \bar{x}_c) = \sqrt{\frac{\operatorname{var}_t}{n_t} + \frac{\operatorname{var}_c}{n_c}}$$

where var_t is the variance in the treatment group, var_c is the equivalent variance in the control group, n_t is the number of data points in the treatment group and n_c is the same for the control group. In this case, $n_t = n_c = 12$. Therefore it follows that the *t*-statistic is given by the equation

$$t = \frac{\bar{x}_t - \bar{x}_c}{\sqrt{\frac{\operatorname{var}_t}{n_t} + \frac{\operatorname{var}_c}{n_c}}}$$

One more parameter needs adding to this formula. The t-statistic is very useful in showing deviations from expected distributions, but without a *critical value* above which the distributions are statistically different, the t-statistic is rather meaningless. Much work has been done into these critical values, and they remain an area of contention. Furthermore, the techniques for deciding on the value range from comparisons with tables of data for the

Augmented Dickey Fuller regression, to repeated Monte Carlo simulations (Phillips, Wu & Yu 2009). The technique outlined in Gilbert (2010) uses the following approximation for the critical value, τ_{CV}

$$\tau_{CV} = \frac{2}{3}\ln(\ln n)^2$$

where *n* is the number of observations to that point. Finally, Gilbert (2010) stipulates that the length of a financial bubble is important, and therefore sets a minimum time-span for a financial bubble as 3-months consecutively above the critical value. This thesis sets the minimum time-span for daily bubbles as 10 days, which is actually larger than that set by Gilbert (2010). The results of this test are shown in Section 6.7.1.

6.6.2 Granger Causality

The Granger causality test is a well-established procedure for ascertaining (Granger) causality in econometrics and other disciplines. Although it does not imply *actual* causality (there could be a host of reasons causing apparent causality in two series, including market fundamentals), Granger-causality is generally considered a good measure of statistical coincidence. In this case, it was used to discover whether fluctuations in one market Granger-cause fluctuations in another, or vice-versa. According to the EMH, markets should move independently of each other and causality should not exist unless due to fundamentals (the price of crude oil compared with heating oil, for example) (Robles et al. 2009). The two experiments looked for Granger causality between LME Copper spots and 3-month futures prices, as well as the FTSE100 index against LME copper 3-month futures.

The general form of the Granger Causality test is shown below. It involves two series which are compared with each other according to varying time differentials, known as lags. The test considers a bivariate linear autoregressive model of two variables, X_1 and X_2 such that

$$X_1(t) = \sum_{j=1}^{p} A_{11} X_1(t-j) + \sum_{j=1}^{p} A_{12} X_2(t-j) + E_1(t)$$

$$X_2(t) = \sum_{j=1}^{p} A_{21} X_1(t-j) + \sum_{j=1}^{p} A_{22} X_2(t-j) + E_2(t)$$

where *p* is the model order, the maximum number of lags included in the model, and the matrix *A* includes the model coefficients (such as the contribution of each lagged observation to the predicted values of $X_1(t)$ and $X_2(t)$). E_1 and E_2 are the residual prediction errors for each time series. If the variance of E_1 (or E_2) is reduced by the inclusion of X_2 (or X_1) then it is said that X_2 (or X_1) Granger-causes X_1 (or X_2). Measurement of Granger causality is given by the F-statistic, while the p-value gives statistical significance to the result. Thus the tables in Section 6.7.2 include 99%, 95% or 90% statistical significances. A 99% result implies less than 1% probability of noise causing a result significantly away from the null hypothesis, denoted H_0, which in this case is that spots and futures prices (or FTSE100 and 3-month futures prices) do not lead one another (Seth 2007).

Following the techniques set out in Hernandez & Torero (2010), linear Granger Causality tests were performed for daily closing prices across a number of different time intervals. As prices are not necessarily stationary over time, the daily returns (Section 6.5.2) of spots, futures and the FTSE100 index were measured instead of daily closing prices. Series were imported into the online Bivariate Granger Causality Test provided by Wessa (2008), and then collated in Excel. Tests were performed over various time intervals, from almost the entire data set (January 1980 to January 2012), to periods of ten years, and then to yearly or quarterly intervals. As mentioned above, Granger looks at interactions of data points in a series at different intervals, known as lags. In many cases the choice of lags is fundamentally important to the results, as shown in Section 6.7.2.

6.7 Results

6.7.1 t-test

T-tests were performed using two distinct data sets. The results shown below use deviations in monthly price data (*Figure 26*) and in daily returns (*Figure 27*) to give a two-level perspective. More on the methodology behind daily returns is given in Section 6.5.2.

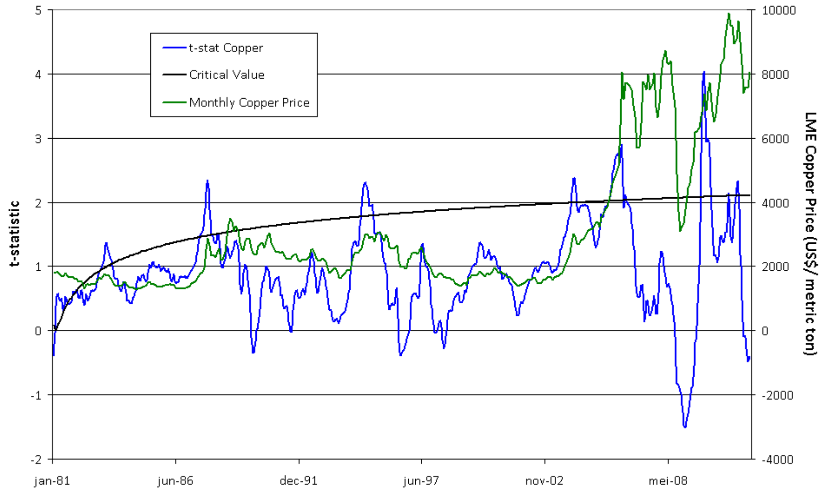


Figure 26: t-statistics for LME monthly copper prices (blue) compared to actual monthly prices (green) and the critical value (black)

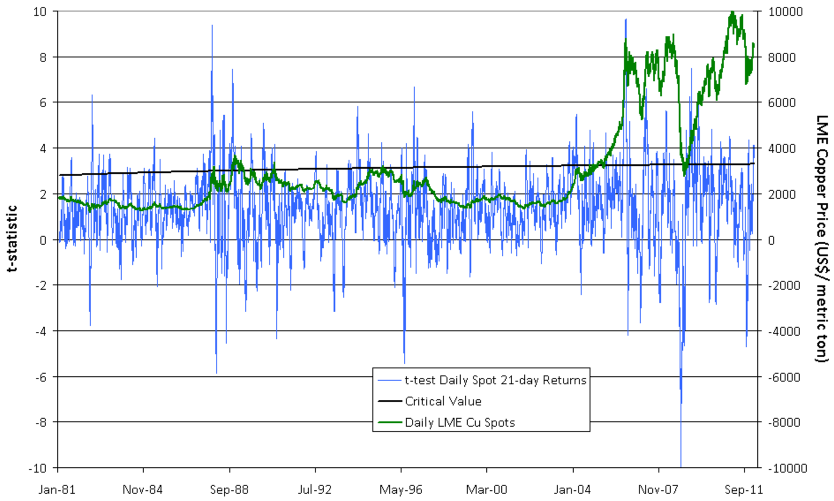


Figure 27: t-statistics for LME daily copper returns (blue) compared to actual daily spot prices (green) and the critical value (black)

In both plots, peaks can be seen around late 1987 and mid-1996, showing the presence of financial bubbles at two times which correspond with periods of increased volatility, as described in Section 6.5.3. The recent crisis presents more interesting results. Monthly t-statistics show the existence of financial bubbles between March and June 2004, October 2005 and August 2006 and from December 2009 to June 2010, while the daily return data suggests major bubbles in the April of 2006, 2007 and 2009. Shorter bubbles were observed in March 2004, March 2007, August 2009 and January 2011. While the graph of monthly data is easy to read, the frequency of fluctuations in daily returns makes *Figure 27* much more difficult to interpret. Therefore *Figure 28* presents the data by superimposing the periods of bubble-like behaviour, evident in monthly and daily returns data, onto the LME price curve in a style similar to that of Gilbert (2010) shown in *Figure 16*.

This visualisation shows extra detail not immediately evident in *Figures 26* & *27.* The monthly bubble in late 1987 covered the months around the peak of prices, whilst the daily returns bubble only included the peak. In 1995 a small daily returns bubble pre-dated the monthly one by a couple of months, whereas February to April 2004 saw contemporary bubbles at both levels. There is also a multi-level bubble seen running from October 2005 to May 2006, when the price of copper more than doubled from around US$4000 to a peak of $8700.

One limitation to this technique is that it is only capable of searching for positive, upwards bubbles. The tests outlined in Section 6.5.3 suggest the possibility of a negative bubble leading to the bottoming out of the market in December 2008, but while these t-tests can pick a number of bubbles on the recovery through 2009 and 2010, it is beyond their reach to confirm what would be the opposite of irrational 'exuberance'.

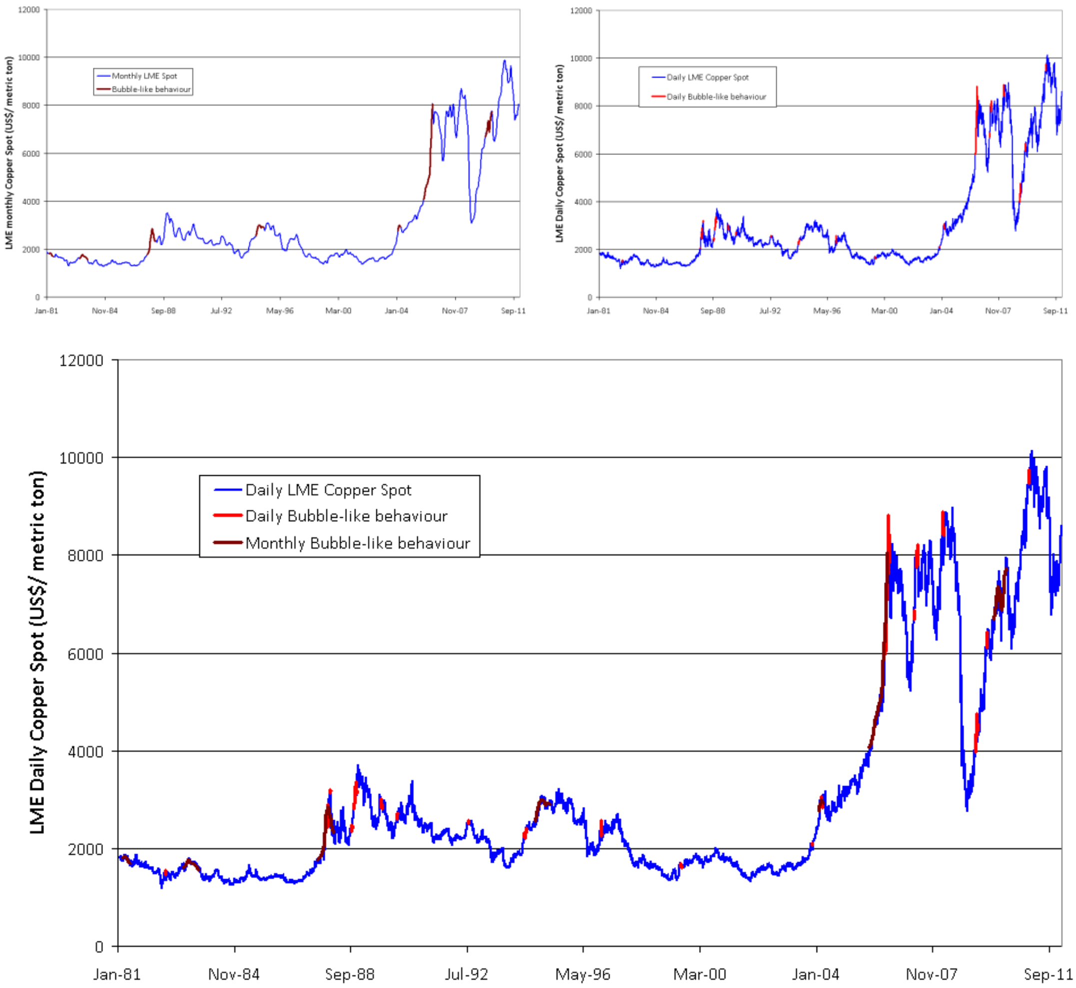


Figure 28: *Top left*: Existence of monthly bubbles (dark red) superimposed onto Monthly LME data. *Top right*: Bubbles in daily spots returns (red) on top of daily LME spots prices (blue). *Bottom*: Combination of bubbles in daily returns (red) and monthly prices (dark red) against daily LME spot prices (blue).

6.7.1a t-test – Sensitivity Analysis

While the results outlined above provide good correlations with the presence of historical financial bubbles, the choice of data for the control group appears arbitrary. A sensitivity analysis was therefore performed by changing the control group from 1980 data to figures from the year 2000. In many ways this is a logical step. January and February 1980 saw sizeable volatility in copper prices (as can be seen on the left-hand side of *Figure 23*). Therefore 1980 can be considered a reasonably volatile year. 2000, on the other hand, saw no such spike in volatility and no suggestion of speculative bubbles. *Figure 29* shows the results.

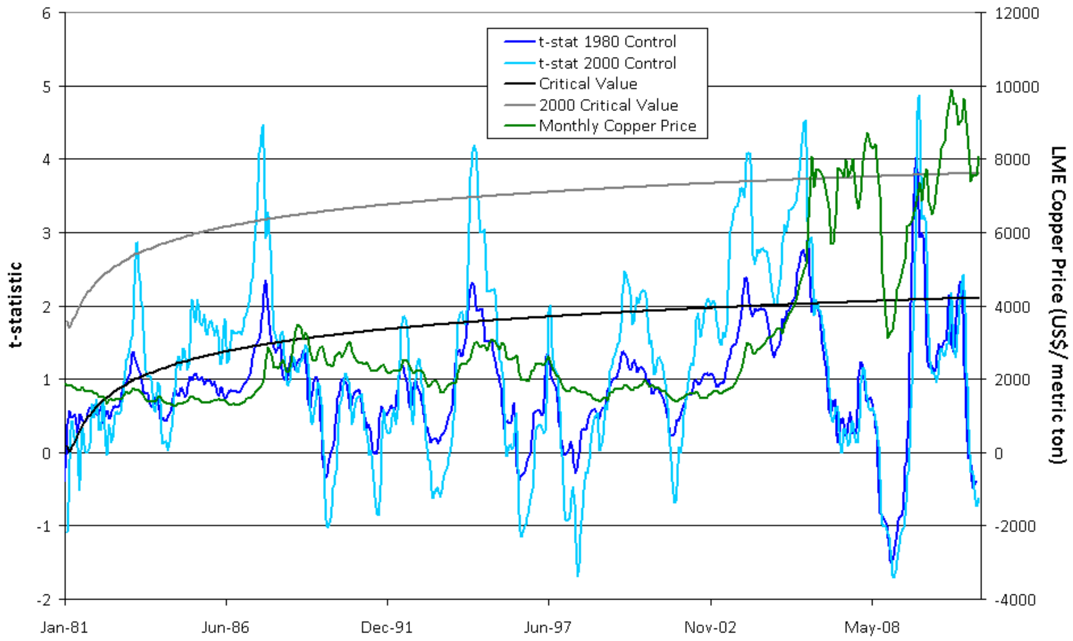


Figure 29: Sensitivity analysis comparing equivalent t-statistics using 1980 (royal blue) as the control group, and 2000 (sky blue)

As the t-statistic is highly dependent on the difference in means between control and treatment groups, the lower mean values seen in 2000 go to produce results which exhibit similar fluctuations with higher amplitude. Therefore rather than two discrete bubbles in 2004 and 2005/6, the 2000 Control data suggests a continuous bubble between August 2003 and June 2006. This, however, could be accounted for by manipulating another apparently arbitrary number, that of the Critical Value. Pushing this value higher (grey line) would mean the results are closer to the results of the 1980 groups, although as the two plots have become much closer since the middle of 2006, this changing of the critical value would then underestimate the size of the 2009/10 bubble, and completely miss the one in May-November 2011. This sensitivity analysis suggests something referred to in Section 6.6.1; while this technique can pick out (positive) bubbles, the exact timing of the bubble is slightly arbitrary and therefore cannot be seen as 100% accurate.

6.7.2 Granger Causality

As detailed in Section 6.6.2, Granger causality tests were carried out across various time periods for two distinct sets of data. The first results considered are those of LME Copper spots and 3-month futures, while the second test involved FTSE100 prices against LME copper. Both experiments are described below.

6.7.2a Granger Causality – Copper Spots and Futures

Firstly the influence of futures price fluctuations were compared to spot fluctuations in the daily closing prices of both markets. Because of issues with non-stationarity of the series, daily returns were compared. Table 3 shows the results for a 30-year period between January 1980 and January 2012, while Table 4 shows the results of tests performed over 3 10-year periods and a shorter period of around 6 years following copper's peak in May 2006. Overall (Table 3), the influence seems to be bi-directional. While one side is larger than the other, they are both within the 99% probability across all lags. This implies the price of copper is jointly defined in different markets.

Lags	F-statistic	
	Fut=F(Spot)	Spot=F(Fut)
1	34.66666***	17.40711***
2	17.61605***	9.60788***
3	12.26783***	8.40235***
4	9.45939***	8.08675***
5	8.08992***	6.86107***
6	7.23720***	6.69913***
7	6.21140***	5.84246***
8	5.39807***	5.82121***
9	4.82330***	5.19306***
10	4.34175***	4.62943***

Table 3: F-statistic for Spots leading Futures prices (left column) and Futures leading Spots prices (right) for period January 1980 to January 2012.
*** indicate better than 99% probability of a statistical result

Lags	1 Jan 1980 – 31 Dec 1989		1 Jan 1990 – 31 Dec 1999		1 Jan 2000 – 31 Dec 2009		10 May 2006 – 31 Jan 2012	
	F=F(*S*)	*S*=F(*F*)	*F*=F(*S*)	*S*=F(*F*)	*F*=F(*S*)	*S*=F(*F*)	*F*=F(*S*)	*S*=F(*F*)
1	19,604***	14,382***	13,896***	23,897***	11,229***	0,000	5,837***	0,000
2	10,924***	7,939***	8,795***	13,349***	9,293***	0,888	11,141***	4,142**
3	8,586***	9,444***	5,810***	9,011***	6,467***	0,624	8,628***	3,226**
4	6,694***	8,585***	4,977***	6,806***	4,860***	0,830	6,959***	2,971**
5	5,847***	8,243***	4,081***	5,854***	4,199***	0,565	5,803***	2,430**
6	5,099***	7,208***	4,189***	6,946***	3,526***	0,533	4,906***	2,037*
7	4,352***	5,984***	3,837***	6,528***	3,085***	0,517	4,122***	1,675
8	4,045***	5,302***	3,433***	6,180***	3,084***	1,472	3,556***	1,629
9	3,830***	4,943***	3,074***	5,479***	2,744***	1,317	3,022***	1,446
10	3,572***	4,560***	2,927***	5,123***	2,441***	1,158	2,617***	1,351

Table 4: F-statistics for Spots leading Futures prices (*F*=F(*S*)) and for Futures leading Spots prices (*S*=F(*F*)) for three periods of 10 years and one period of 5 years 1 month
*** 99% probability of a statistical result, ** 95% probability and * 90% probability

While Table 3 is inconclusive as to the directionality of Granger causality, Table 4 adds some fascinating detail. Up to the turn of the millennium, 10-yearly statistics support the dual-directionality described above. However, during the 2000s there is a marked change in direction of Granger causality. It appears that during the first decade of the millennium, spot prices lead futures prices.

6.7.2b Granger Causality – FTSE100 financial index and LME Copper

An observation made in Section 6.5.1 noted that fluctuations in the FTSE100 and the LME copper price appear to be moving in parallel – especially following the credit crunch in 2008. Therefore Granger causality tests were performed to discover the influence of the financial index on copper prices. Table 5 shows the results for the period 2 January 2001 to 31 January 2012, and the findings are striking. The influence of the FTSE100 on both futures and spot price fluctuations appears indisputable, while there is no influence the other way around. It implies that movements in financial markets (of which the FTSE is just one example) clearly determine fluctuations in the copper market. While the results shown above are inconclusive as to financial influence on actual commodity prices, this result appears to show that financial markets do indeed have a strong influence on commodity prices.

Lags	FTSE100 vs Cu 3-month Futures		FTSE100 vs Cu Spots	
	FTSE Leads LME Cu	**LME Cu Leads FTSE**	**FTSE Leads LME Cu**	**LME Cu Leads FTSE**
1	148,593***	0,050	131,652***	0,095
2	75,070***	1,243	66,848***	1,056
3	50,732***	1,830	45,214***	1,814
4	38,129***	0,585	34,046***	0,595
5	30,488***	0,722	27,234***	0,676
6	25,261***	0,878	22,569***	0,910
7	22,137***	1,009	19,721***	1,021
8	19,122***	0,967	17,043***	0,973
9	17,233***	0,920	15,541***	0,944
10	16,275***	1,424	14,743***	1,538

Table 5: F-statistics for Granger causality of the FTSE100 against LME copper 3-month futures (left) and spots (right) for the period January 2001 to January 2012
*** 99% probability of a statistical result, ** 95% probability and * 90% probability

Although Table 5 shows some fairly conclusive results, it is also interesting to consider whether this is a lasting phenomenon or merely one that has occurred in the past few years. Certainly *Figures 20* and *21* suggest that this cointegration became more striking following the Credit Crunch. Therefore Tables 6A and B show the annual F-statistics for Granger Causality of the FTSE100 on LME Copper (top) and vice versa (below). The p-values have been included in provide a measure of statistical significance, whereby a value of less than 0.1 equates to a 90% probability of a statistical results, 0.05 to a 95% probability and 0.01 a 99% probability.

Year	FTSE 100 Granger causes LME Cu 3 Month					
	lag=1		lag=5		lag=9	
	F	p-value	F	p-value	F	p-value
2011	0,49	0,49	1,09	0,37	0,63	0,77
2010	37,65	3,31E-09	7,93	6,26552E-07	4,25	4,1438E-05
2009	36,68	5,1E-09	8,50	2,04851E-07	4,98	4,0187E-06
2008	46,17	7,9E-11	10,10	8,71286E-09	5,64	4,9301E-07
2007	23,57	2,12954E-06	5,14	0,000169001	3,31	0,00083
2006	2,31	0,13	3,96	0,001798368	2,55	0,00820037
2005	0,34	0,56	1,57	0,17	1,74	0,08
2004	2,61	0,11	1,04	0,39	0,56	0,83
2003	4,24	0,04	1,85	0,10	1,62	0,11
2002	0,01	0,91	1,79	0,12	1,31	0,23
2001	0,23	0,63	0,33	0,89	0,84	0,58

Table 6A: Annual F-statistics for Granger Causality of the FTSE100 upon the LME 3-month futures price. P-values indicate probability of a statistical significant result – Less than 0.1 equates to a 90% probability, less that 0.05 a 95% probability and less than 0.01 a than 99% probability.

Year	LME Cu 3 Month Granger causes FTSE 100					
	lag=1		lag=5		lag=9	
	F	p-value	F	p-value	F	p-value
2011	12,70732	0,00044	3,33844	0,00622	2,74667	0,00462
2010	0,51377	0,47418	1,48030	0,19695	2,07657	0,03260
2009	0,13831	0,71028	0,63471	0,67343	0,75358	0,65946
2008	7,03022	0,00853	0,76631	0,57489	0,94820	0,48412
2007	1,72378	0,19042	0,55538	0,73414	0,44567	0,90894
2006	0,39499	0,53026	1,16649	0,32637	0,54880	0,83766
2005	0,47966	0,48923	0,43735	0,82221	0,61145	0,78674
2004	1,42108	0,23436	0,94030	0,45553	0,74292	0,66929
2003	2,23927	0,13581	0,79845	0,55173	2,73448	0,00478
2002	6,99084	0,00872	2,01380	0,07748	1,27376	0,25229
2001	0,05433	0,81588	0,66178	0,65282	0,52795	0,85346

Table 6B: Annual F-statistics for Granger Causality of the LME 3-month futures price upon the FTSE100..

As observed in Section 6.5.1, cointegration becomes much more pronounced around the time of the credit crunch, although the FTSE100 actually seems to start influencing copper prices as early as 2006, especially when considering longer lag times, as shown graphically in *Figure 30*. However, the largest effects of this financial dominance over commodity prices seem to have gone from the second half of 2007 up until around the third quarter of 2010. Indeed, by 2011 we have the seemingly ridiculous situation that the copper price appears to be leading the FTSE100. While copper alone cannot be unduly influencing the financial markets, this could show the effects of commodity-based investments such as oil futures or commodity index-funds on movements in the financial markets.

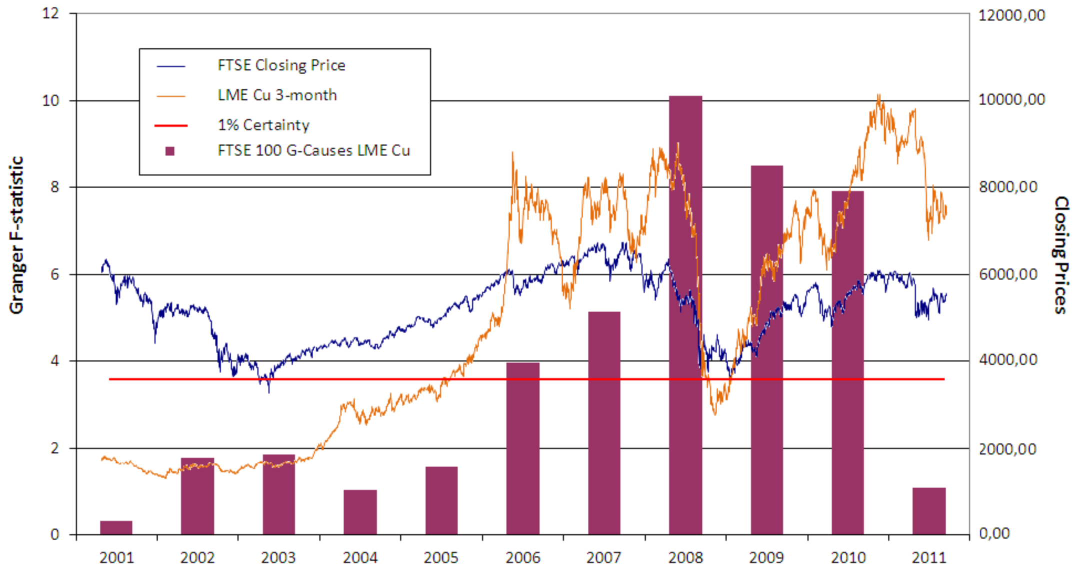


Figure 30: Granger F-statistics for the FTSE100's influence over LME 3-month copper prices at lag=5, superimposed onto linear plots of the FTSE100 and LME Copper daily closing settlements. The red line indicates 99% probability of statistical significance.

6.7.2c Granger Causality – Sensitivity Analysis

As is clear above, the choice of lag time is important and its influence on the sensitivity of results is well documented (see Thornton & Batten (1984) for example). That said results are surprisingly consistent across lag times as shown in all tables above.

The choice of period of study is another one which influences results. It is difficult to reduce the size of units too far as it increases the possibility of random statistical coincidences. Therefore while the choice of tests on 30-year, 10-year and annual data may not provide a great deal of resolution, it does at least aim to ensure that the results are reliable. An example of the contrary can be seen in *Figure 31*, whereby small data sets of just one month (sometimes with as few as 20 data points) were compared. Lag times have a great influence at this level, to such an extent that the results appear fairly meaningless – spikes occur in different places at apparently random times, especially when compared with the light blue 'monthly settlement' line.

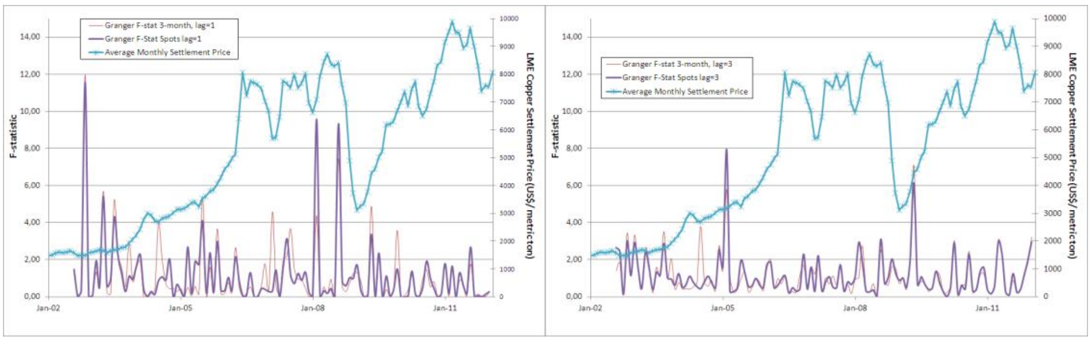


Figure 31: Granger causality tests for LME spots' influence on 3-month futures and vice-versa, performed on monthly data at lags of 1 (left) and 3 (right)

6.8 Discussion

The preliminary tests (Section 6.5) appear to show results in-keeping with those found in the literature. *Figure 20* & *Figure 21* show graphically the cointegration between equities and commodities also found by Basu & Gavin (2011), amongst others. Granger-causality tests carried out on this data show that, during the period between the second half of 2007 and the third quarter of 2010 the FTSE100 equities index Granger-caused fluctuations in daily returns of 3-month Grade-A LME copper futures. It has been shown, by Büyükşahin & Robe (2010) and others, that cointegration usually occurs during periods of 'economic stress'. Certainly, Table 2 shows that volatility (as measured by the standard deviation) increased significantly from May 2006 onwards, showing both spots and 3-month copper futures were experiencing 'economic stress'.

Interestingly, this cointegration apparently started in 2007, a whole year before the Federal takeover of Fannie Mae & Freddie Mac and the subsequent collapse of Lehman Brothers, showing that economic stress on financial and commodities markets was triggered as much by the subprime crisis as by the subsequent credit crunch and collapse of financial institutions. Many papers have placed the blame for cointegration on hedge funds and/or Commodity Index Funds. As both of these investment vehicles are present across both equities and commodities markets, there could be some validity to this argument. Interestingly, after 2010 the two markets appear to have become less integrated – indeed during 2011 the results suggest LME 3-month futures were Granger-causing the FTSE100. This is where it is important to draw a distinction between *real* causation and Granger-causality. Granger implies only a statistical correlation, and therefore does not necessarily mean copper prices are ruling financial markets. Nevertheless, as copper is an integral (if small) component of both the S&P-GSCI and the DJ-UBSCI (see Section 3.4.2), this result may suggest an increased influence of commodity indices, especially the oil component, on financial markets, or indeed some larger effect of hedge fund market strategies. To test these hypotheses one could begin by looking at Granger-causality between commodities indices and financial ones, as well as between other indexed and non-indexed commodities, and different financial indices or indicators.

The results of Granger-causality tests on spots and futures prices are less conclusive then those discussed above. Both spots and 3-month futures prices were shown to Granger-cause each other, a situation which, according to Dwyer, Holloway & Wright (2012) could be due to a large number of participants with access to both markets or "institutional factors which enforce a close mechanical relationship between the two markets". As a highly liquid commodity, this explanation seems reasonable for copper. What is more, through investment vehicles such as ETFs and ETNs (Section 3.4.2) financial investment seems to be influencing copper spot prices as well as futures. Indeed, looking at the right-hand columns of Table 5 seems to confirm this idea – the FTSE100 notably Granger-causes LME copper spot prices, a result not necessarily expected. However, the non-causality of futures on spots is a slightly surprising result. It has been shown in many studies (as described in Hernandez & Torero (2010)) that futures prices lead spot prices across a basket of agricultural storable commodities, including corn and wheat. Indeed, many of those results are striking in the influence of one market over the other. With copper, however, it sometimes appears that spots are indeed leading futures price fluctuations, suggesting either the fundamental nature of this market or the influence of financial investment in spots as well as futures. Probably the reality lies somewhere between those two states.

The t-tests performed on both daily and monthly data, meanwhile, showed evidence of *sub-martingale* (or explosive) behaviour of market prices at various times since 1981. Evidence for financial bubbles can be found in late-1987 and again in mid-1996, periods in which 'irrational exuberance' was accepted as being present on financial and commodities markets. Having calibrated these results accordingly, much deeper bubbles were found on numerous occasions since 2004.

Maybe the most disturbing finding from this analysis is the sizeable and multi-level bubble stretching from October 2005 to May 2006, when the price of copper more than doubled from around US$4000 to a peak of $8700. This result suggests financial speculation could have an influence on price levels as well as simply market volatility. In many natural and mechanical systems the idea of bistability is well accepted, wherein a system can exist stably in either of two states, but not in-between (an example could be a stable area of natural grassland in one state, or a stable swamp in its second state, but not an area of wet grassland). It's an interesting concept to apply this idea to copper prices. One stable state could be between $2-3000/ton, and another around $8000/ton. Although the second state is notably more volatile, only time will tell if prices remain at this high level, or will drop back to their original state (something which looks unlikely given potential future supply challenges). If that is the case, then the financial bubble between October '05 and May '06 could have been responsible for the transition to the second state and therefore excessive speculation could be said to influence market prices, not just volatility.

While the method for finding these bubbles was not as rigorous as those applied by Phillips, Wu & Yu (2009) or Gilbert (2010), this technique does seem to be able to detect bubbles earlier on - as Gilbert himself points out, his technique can only identify the tail-end of bubbles. There remains the possibility that this lack of rigor could identify bubbles which are less influential, or more controversial, and are therefore not picked-up in the more advanced methods of the econometricians.

Finally, part of this thesis may fall down through the resolution of the data. The smallest unit of publically available data is the daily closing price. However, when trades take place at up to 40,000 per second (see Section 3.5.1), daily data may not carry the amount of detail required to perform thorough statistical analyses. Flash crashes sometimes last a matter of seconds, yet have a huge influence on real-world returns, even if the system is often able to restore itself almost instantaneously. Therefore to achieve more accurate results, future studies in this area will need to focus on higher resolution data over smaller time-intervals, in addition to daily, weekly and monthly data showing longer-term trends.

8. Conclusions

The past 10 years has seen an unprecedented increase in financial investment in commodities. While the exact effects of this investment remain controversial, not least because of the lobbying power of many involved in the business and uncertainties due to a lack of data, there are some general indications that can be taken from the literature, as well as the conclusions drawn from tests performed as part of this master's thesis, in order to answer the research question, and sub-questions, outlined in Section 1.2. These conclusions will answer the first three sub-questions in order, before coming to a general conclusion to answer the main research question.

1. *How have financial and commodities markets developed over recent decades and can this be said to have had an influence on the price-setting function of such markets?*

Following the stock market crash of 1929 and the subsequent depression, excessive financial speculation was seen as a major problem in price-setting of commodities. Therefore strict regulations of such markets were introduced in the 1930s in an attempt to safeguard the price-setting function of the exchanges. It was not until the year 2000 that the Commodity Exchange Act (CEA) of 1936 was finally repealed by the outgoing Clinton administration, but by then off-exchange, Over-the-Counter trades – banned by the CEA – were already becoming important. The strict Position Limits allowed by the CEA were first relaxed and then discarded due to both difficulties in enforcement and a general belief in the Efficiency of Markets. Thereafter investment in commodities ballooned, through trading strategies such as commodity indices, which saw investment balloon more than 10-fold between 2003 and 2008. Likewise, *dark pools* out of the sight of regulators sprang up in the OTC swap derivatives market, which increased investment in unregulated, largely uncleared commodity futures by 20 times, to over €13 trillion at the outset of the credit crunch. This process is generally known as the financialisation of commodities markets, and coincides with unprecedentedly high price levels for many traded commodities.

2. *What policy options have been proposed and enacted by the European Union and the US Federal government, how can/do they influence commodity markets and what barriers do they face in implementation?*

Following the credit crunch and a growing acceptance of the need for regulation of finance, legislation is currently passing through both the European Parliament, in the form of MiFID II, and the US Congress (Dodd-Frank) in an attempt to regulate commodity markets. The regulations are vast and wide-ranging, but involve the re-imposition of position limits and efforts to ensure greater use of commodity exchanges for trades, rather than simply allowing the OTC market to continue its expansion. Regulators are wary of the systemic risk in so-called derivative swaps, and are therefore working to force all trades to be cleared in order to lower counter-party risk. However, in an increasingly globalised world it is becoming ever more difficult to avoid regulatory arbitrage, as exemplified by the London Loophole (Section 4.2.2). Therefore, while a number of options remain open to regulators on both sides of the Atlantic, two major obstacles continue to impede effective commodity market regulation, namely that the size of the OTC market makes it very difficult to force these trades onto exchanges, and that emerging financial centres outside the jurisdiction of these regulators will not be subject to the same rules without widespread international agreement.

3. *How has commodities market behaviour been modelled mathematically, using econometrics and how can this be used to provide quantitative analysis of the speculative effects on LME copper?*

There has been a lot of work done on the details of financial and commodity market behaviour – not least because of the huge sums involved in the business. Although price formation theories set out by major economists (Keynes, Friedman, Fama) enjoy wide-spread acceptance by both academic and financial economists, it is only through the application of tests on these theories that they can be proven or otherwise for specific commodities on certain markets. This field of study is known as econometrics, and a number of econometric tests, sourced in the literature, were found to test the validity of the Efficient Market Hypothesis on Grade-A copper traded on the London Metals Exchange. Specifically these were t-tests to look for bubble-like behaviour of prices, and Granger-Causality tests to investigate correlations and statistical causation between different markets (the FTSE100 and 3-month LME copper) and between future and spot prices (of LME copper). These tests were augmented by some basic statistical analysis.

To what extent, and in which ways, does excessive financial speculation on commodities influence the market price of globally traded commodities?

The tests performed on LME copper market data suggest that excessive speculation has had a major impact on the benchmark price of that metal, while other studies have shown similar results for different commodities. Specifically, cointegration of price movements across commodity and other markets was at a remarkably high level during the turbulent conditions evident between 2007 and 2010, and as this thesis shows, a strong statistical Granger-causality was seen in LME copper emanating from the FTSE100. While the FTSE100 index was not the real-world cause of price movements in copper, it demonstrates the effect that finance has had on commodity price fluctuations. Furthermore, financial price bubbles were identified in copper spot closing prices at daily and monthly resolutions. Minor bubbles were shown in 1987, 1995, 2004, 2008 and 2011, although the most sustained bubble was seen between October 2005 and May 2006, when prices went from US$4000/ton to US$8700/ton. Using the bistability idea set out in the previous section, there exists the possibility that a financial bubble could have been responsible for the higher pricing regime seen since then. This may chime with Gilbert's assertion that the copper price of $8200/ton in April 2008 would have been at $6800 without the influence speculation (in his case from indices – see Section 3.4.2a).

Although much of the discussion seen in this thesis regarding the financialisation of commodities markets may be common knowledge amongst academic financial economists, within other spheres, including the master's course on Sustainable Development at Utrecht University, the perceived difficulties in understanding these concepts mean that many remain unaware of the changed circumstances in commodities markets since the turn of the millennium. In that way, this thesis adds a different angle to the discussion on pricing of basic commodities within environmental sciences. At the same time this work adds to a growing body of financial economic evidence around the adverse effects of financialisation on commodities markets.

9. Recommendations

The second part of the main research question, augmented by sub-question 4, ask for recommendations on how to *improve the price discovery function of commodities markets, and hence produce a more sustainable market for basic commodities*. These recommendations are general in nature and are sourced from the contents of this thesis.

As the previous sections have shown, excessive speculation in commodities markets is a persistent problem, and is becoming accepted as such amongst legislators and the general public alike. As the tax payer is ultimately liable for bad debts, being the lender of last resort, there is a strong public interest in ensuring that all financial markets minimise systemic risk. Therefore actions such as bringing Over-the-Counter swaps deals into the view of regulators, while also insuring against counterparty defaults through the use of clearing, should be supported. Furthermore, while this thesis does not explicitly examine the effects of position limits on commodities markets, the accepted wisdom is that they are necessary to avoid dominant position taking in various markets. That they should also be agreed multi-laterally has proved problematic, but political and economic efforts should nonetheless be made towards such a step.

Meanwhile, this thesis has shown that LME copper (and other commodities) has become more susceptible to severe price bubbles since around 2004. Much of this blame apparently lies with algorithmic trading, which now accounts for a large share of commodity market trades. This is an innovative area of finance and therefore the strategies employed are highly fluid. For that reason, specific legislation to deal with innovations takes far too long to pass. Therefore regulators should be given the authority to impose specific, appropriate rules in a timely manner, under their general responsibilities for ensuring market manipulation is not present. Some examples of these specific regulations are given in section 4.4, and include speed limits for transactions and transaction taxes, especially during periods of high economic stress.

However, implementation of rules is impeded by the existence of a number of different regulatory authorities with overlapping responsibilities (such as the clashes between the CFTC and SEC during the 1990s referred to in section 4.1). Efforts should necessarily be made to limit the number of bodies responsible for regulation – a move which would function better with international bodies rather than national or regional ones. While there are many obstacles to the formation of a single international financial regulator, in an era of global finance the only way to police such markets is through a global body responsible for ensuring commodities pricing is as free from manipulation as possible. The effects of price hikes in agricultural commodities are well documented, but the modern world also relies heavily upon metals and fuel to oil the wheels of the economy. If sustainable development is to be possible at all, it will always be impeded as long as financial traders continue to take money out of the real economy in order to benefit investors at the expense of normal citizens, not least because of the uncertainty created by highly fluctuating prices. In other words, commodity markets should be seen as being too important to be left only in the hands of finance.

References

Abbott M., *Interview with Sedgwick S., Das S., and Seetharaman M.*, CNBC in Europe, London, 29 September 2011, http://www.lme.com/12297.asp, Retrieved 10 January 2012

Alper A. and Lynch S.N., *UPDATE 6-US regulators spare all but biggest swap dealers*, Reuters, 18 April 2012 http://www.reuters.com/article/2012/04/18/financial-regulation-swaps-idUSL2E8FI44Y20120418, Retrieved 14 May 2012

Arnuk S.L. and Saluzzi J., *Toxic Equity Trading Order Flow on Wall Street: The Real Force Behind the Explosion in Volume and Volatility*, A Themis Trading LLC White Paper, 2008

Armitstead L. and Mason R., JP *Morgan revealed as mystery trader that bought £1bn-worth of copper on LME*, Daily Telegraph, 4 December 2010, http://www.telegraph.co.uk/finance/newsbysector/industry/8180304/JP-Morgan-revealed-as-mystery-trader-that-bought-1bn-worth-of-copper-on-LME.html Retrieved 30 November 2011, Retrieved 10 January 2012

Avery C. and Zemsky P., *Multidimensional Uncertainty and Herd Behavior in Financial Markets*, The American Economic Review, Vol. 88, No. 4, pp. 724-748, September 1998

Baffes J. and Honiotis T., *Placing the 2006/08 Commodity Price Boom into Perspective*, Policy Research Working Paper 5371,the World Bank: Development Prospects Group, July 2010

Basu P. and Gavin W.T., *What Explains the Growth in Commodity Derivatives?*, Federal Reserve Bank of St. Louis Review 93(1), pp. 37-48., January/February 2011

Bekiros S.D. and Diks C.G.H., *The relationship between crude oil spot and futures prices: Cointegration, linear and nonlinear causality*, Energy Economics 30 pp 2673–2685, 2008

Biais B. and Woolley P., *The flip side: high frequency trading*, financialworld.co.uk, February 2012

Bilson J.F.O., *The "Speculative Efficiency" Hypothesis*, The Journal of Business, Vol. 54, No. 3, pp. 435-451, July 1981

Blas J. and Farchy J., Glencore reveals bet on grain price rise, ft.com>markets>commodities, 24 April 2011, http://www.ft.com/cms/s/0/aea76c56-6ea5-11e0-a13b-00144feabdc0.html#axzz24kHGEzly, Retrieved 27 August 2012

Bradley H. and Litan R.E., *Choking the recovery: Why New Growth Companies Aren't Going Public, and Unrecognized Risks Of Future Market Disruptions*, The Ewing Marion Kauffman Foundation, 8 November 2008

Brenner R.J and Kroner K.F., *Cointegration, and Testing the Unbiasedness Hypothesis in Financial Markets*, Journal of Financial and Quantitative Analysis, Vol. 30, No. 1, March 1996

Brigo D., Chourdakis K. and Bakkar I., *Counterparty Risk Valuation for Energy-Commodities Swaps*, Fitch Solutions, London, 24 June 2008

Browning E.S., *Exorcising Ghosts of Octobers Past*, The Wall Street Journal, 15 October 2007, http://online.wsj.com/article/SB119239926667758592.html?mod=mkts_main_news_hs_h#MARK, Retrieved 22 June 2012

Bryant H.L., Bessler D.A. and Haigh M.S., *Causality in Futures Markets*, The Journal of Futures Markets, Vol. 26, No. 11, 1039–1057 (2006)

Büyükşahin B., Haigh M.S., Harris J.H., Overdahl, J.A. and Robe M.A., *Fundamentals, Trader Activity and Derivative Pricing*, CFTC, Washington, 4 December 2008, http://ssrn.com/abstract=966692 Retrieved 25 September 2011

Büyükşahin B. and Robe M.A., *Speculators, Commodities and Cross-Market Linkages*, November 2010

CDA (Copper Development Association), *Annual Data 2011 - Copper Supply & Consumption 1990-2010*, New York 2011

CDA, *Copper – the World's Most Reusable Resource*, http://www.copper.org/environment/g_recycl.html, Retrieved 26 June 2012

CDA (2012a), *Wind Energy Basics: How Much Copper Is Used In A Wind Farm?*, http://www.copper.org/environment/green/casestudies/wind_energy/wind_energy.html, Retrieved 28 August 2012

CFTC (Commodity Futures Trading Commission). *CFTC Emergency Authority Background*, Washington, D.C., 2008, http://cftc.gov/stellent/groups/public/@newsroom/documents/file/cftcemergencyauthoritybackgrou.pdf Retrieved 25 November 2011

CFTC, *Proposal to Set Position Limits in the Energy Futures and Options Markets*, 14 January 2010

Chang E.C., *Returns to Speculators and the Theory of Normal Backwardation*, The Journal of Finance, VOL. XL, NO. 1, March 1985

Chilton B., *Why the London loophole should be closed*, ft.com: Opinion, 23 June 2008 http://www.ft.com/intl/cms/s/0/99c02980-4127-11dd-9661-0000779fd2ac.html#axzz1uqDR0JDH Retrieved 14 May 2012

Clifford Chance, *The Dodd-Frank Act and the Proposed EU Regulation on OTC Derivatives Impact on Asian Institutions*, London New York and Hong Kong, December 2010

Cohen N., *'Efficient markets hypothesis' inefficient*, FT.com: Regulation & Governance, 24 January 2012 http://www.ft.com/cms/s/0/cb7e1b6e-46bc-11e1-bc5f-00144feabdc0.html#axzz1mGBzQ0WF, Retrieved 13 February 2012

Cooper R., Tobin tax 'could leave €116bn hole in EU finances', Ernst & Young warns, The Daily Telegraph, 9 January 2012, http://www.telegraph.co.uk/finance/financialcrisis/9001256/Tobin-tax-could-leave-116bn-hole-in-EU-finances-Ernst-and-Young-warns.html, Retrieved 27 August 2012

Cox P., Lynton J. and Wells S., *The Competitive Impact of London's Financial Market Infrastructure*, Bourse Consult, London, April 2007

Cravath, Swaine and Moore, *Commodity Futures Modernization Act of 2000 – Memorandum for ISDA members*, Worldwide Plaza, New York, January 2001

Cui C., *Getting Tripped Up by the Contango*, The Wall Street Journal: Commodities Report, 17 December 2010, http://online.wsj.com/article/SB10001424052748704594804575648484003392728.html, Retrieved 27 February 2012

Daily Telegraph, London Metal Exchange: a history, Daily Telegraph, 3 December 2010, http://www.telegraph.co.uk/finance/newsbysector/industry/mining/8179224/London-Metal-Exchange-a-history.html, Retrieved 10 January 2012

De Schutter O., *Food Commodities Speculation and Food Price Crises*, United Nations, September 2010

Domanski D., and Heath A., *Financial investors and commodity market*, BIS Quarterly Review, March 2007

Dow Jones Indexes, *Dow Jones-UBS Commodity Index – Fact Sheet*, 31 May 2012

Dwyer A., Holloway J. and Wright M., *Commodity Market Financialisation: A Closer Look at the Evidence*, Reserve Bank of Australia Bulletin – March Quarter 2012, http://www.rba.gov.au/publications/bulletin/2012/mar/8.html Retrieved 22 August 2012

Edelstein D.L, *USGS Minerals Yearbook: Copper*, USGS, 2010 (and previous years)

Emsley J., *Nature's Building Block – An A-Z Guide to the Elements*, Oxford University Press, 2001

Etula E., *Broker-Dealer Risk Appetite and Commodity Returns*, Federal Reserve Bank of New York Staff Reports, no. 406 November 2009; revised September 2010

European Commission (2011a), *Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on markets in financial instruments repealing Directive 2004/39/EC of the European Parliament and of the Council*, Brussels, 20 October 2011

European Commission (2011b), *Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on markets in financial instruments and amending Regulation [EMIR] on OTC derivatives, central counterparties and trade repositories*, Brussels, 20 October 2011

European Commission (2011c), *Application of EU Law: what are EU regulations?*, 17 August 2011, http://ec.europa.eu/eu_law/introduction/what_regulation_en.htm, Retrieved 15 May 2012

European Commission (2011d), *Impact Assessment Accompanying the document: Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on markets in financial instruments repealing Directive 2004/39/EC of the European Parliament and of the Council*, Brussels, 20 October 2011

Fabozzi F.J., Focardi S.M. and Jonas C., *High Frequency Trading: Methodologies and Market Impact*, Review of Futures Markets, Volume 19 (Special Edition), August 2010, http://www.theifm.org/rfm-special-Issue2011.pdf Retrieved 31 January 2012

Fama E.F., *Efficient Capital Markets: A Review of Theory and Empirical Work*, The Journal of Finance, Vol.25, No. 2, pp. 383-417, May 1970

Fama E.F. and French K.R., *Commodity Futures Prices: Some Evidence on Forecast Power, Premiums, and the Theory of Storage*, The Journal of Business, Vol. 60, No. 1, pp. 55-73, January 1987

Fama E.F. and French K.R, *Business Cycles and the Behavior of Metals Prices*, The Journal of Finance, Vol. XLIII, No. 5, December 1988

Fantacci L., Marcuzzo M-C. Sanfiuppo E., *Speculation in commodities: Keynes' "Practical Acquaintance" with Futures Markets*, Journal of the History of Economic Thought, Volume 32, Number 3, September 2010

Farchy J., *Copper market shrugs off JPMorgan move*, Financial Times, 1 February 2011, http://www.ft.com/cms/s/0/e78b59fa-2dd8-11e0-a49d-00144feabdc0.html#axzz1f5rPfN6H, retrieved 29 November 2011

Farchy J. (2011A), *JPMorgan to buy MF Global's LME stake*, 22 November 2011, http://www.ft.com/cms/s/0/f85f7be2-1533-11e1-855a-00144feabdc0.html#axzz1yuIzYlDu, Retrieved 26 June 2012

Farge E. and Sheppard D., Oil traders slip past U.S. rules via London loophole, Reurters, 9 July 2009, http://www.reuters.com/article/2009/07/09/us-oil-regulation-analysis-idUSTRE5683LX20090709, Retrieved 14 May 2012

Federal Reserve Bank of St Louis, *The Financial Crisis: A Timeline of Events and Policy Actions*, http://timeline.stlouisfed.org/index.cfm?p=timeline#, Retrieved 22 June 2012

Frenk D. and Staff, *Review of Irwin and Sanders 2010 OECD Report*, Better Markets Inc, 30 June 2010

Friedman M., *Essays in Positive Economics*, University of Chicago Press, 1953

FSA (Financial Services Authority & HM Treasury), *Reforming OTC Derivative Markets: A UK perspective*, December 2009

FSA, *Markets in Financial Instruments Directive (MiFID)*, 19 January 2012

Gensler G., *History of derivatives regulation, culprit OTCs*, Commodity Online, 2 July 2010, http://www.commodityonline.com/news/history-of-derivatives-regulation-culprit-otcs-29636-3-29637.html, Retrieved 25 August 2012

Ghosh J., *Implications of regulating commodity derivatives markets in the USA and EU*, PSL Quarterly Review, vol. 64 n.258 (2011), 287 – 304

Gilbert C.L., *Speculative Influences on Commodity Futures Prices 2006-2008*, UNCTAD Discussion Paper, No. 197, March 2010

Goldmansachs.com, *S&P GSCI Components and Weights*, http://www.goldmansachs.com/gsci/insert.html, Retrieved 21 June 2012

Gorton G. and Rouwenhorst K.G., *Facts and Fantasies about commodities Futures*, Yale ICF Working Paper No. 04-20, February 2005

Gorton G.B, Hayashi F. and Rouwenhorst K.G.*, The Fundamentals of Commodity Futures Returns*, Yale ICF Working Paper No. 07-08, September 2008

Goyette M., *The California Energy Crisis 2000-2001: Update on Post-Crisis Developments*, Briefing for the Little Hoover Commission, Office of the Attorney general, 26 September 2011

Grant J., *Quick View: Whose move in the Chi-X end game?*, 17 December 2010, http://www.ft.com/intl/cms/s/0/6438a722-0a03-11e0-9bb4-00144feabdc0.html#axzz1uwwDbgor, Retrieved 15 May 2012

Gsell M., *Assessing the Impact of Algorithmic Trading on Markets: A Simulation Approach*, Centre for Financial Studies Working Paper No. 2008/49, June 2008

H.R. 4173--111th Congress: *Dodd-Frank Wall Street Reform and Consumer Protection Act.* (2009). In GovTrack.us (database of federal legislation). http://www.govtrack.us/congress/bills/111/hr4173, Retrieved 10 May 2012

Harper D., *Contango Vs. Normal Backwardation*, investopedia.com 2 April 2007, http://www.investopedia.com/articles/07/contango_backwardation.asp#axzz1mMrr6JyH, Retrieved 14 February 2012

Hedge Funds Consistency Index, *Standard Deviation*, Fairfield, Iowa, http://www.hedgefund-index.com/d_standarddev.asp Retrieved 25 June 2012

Hernandez M. and Torero M., *Examining the Dynamic Relationship between Spot and Future Prices of Agricultural Commodities*, IFPRI Discussion Paper 00988, June 2010

Hernandez J., *How the Hunt brothers cornered the Silver Market*, PCGS, 6 December 2011, http://www.pcgs.com/Articles/Detail/7040, Retrieved 28 February 2012

Hill P., *'Enron loophole' enables oil speculation*, The Washington Times, 24 June 2008, http://www.washingtontimes.com/news/2008/jun/24/enron-loophole-keeps-oil-speculation-unleashed/?page=all, Retrieved 14May 2012

Hong H. and Yogo M., *Commodity Market Interest and Asset Return Predictability*, 25 March 2010

Hull J.C., *Options, Futures and other Derivative Securities: Second Edition*, Prentice-Hall Inc., New Jersey, 1993

Huber J.,Kleinlercher D., and Kirchler M, *The impact of a financial transaction tax on stylized facts of price returns—Evidence from the lab,* Journal of Economic Dynamics & Control 36 (2012) 1248–1266

IISD, *The Global Initiative on Commodities*, April 2009

IMF, *Global prospects and policies: Chapter 1 Appendix 1*, International Monetary Fund, Washington DC, 2010

IMF, *International Financial Statistics,* Washington, DC: International Monetary Fund, 2012. http://elibrary-data.imf.org, Retrieved 28 January 2012

Investopedia, *CFA Level 1 Study Guide*, http://www.investopedia.com/exam-guide/cfa-level-1/quantitative-methods/statistical-skew-kurtosis.asp, Retrieved 22 June 2012

Irwin S. H. and Sanders D.R., *The Impact of Index and Swap Funds on Commodity Futures Markets: Preliminary Results*, OECD Food, Agriculture and Fisheries Working Papers, No. 27, OECD Publishing, 2010

Irwin S.H. and Sanders D.R., *Index Funds, Financialization, and Commodity Futures Markets*, Applied Economic Perspectives and Policy, volume 33, number 1, pp. 1–31, 2011

Irwin, S. H., Sanders D. R., and Merrin P.P., *Devil or Angel? The Role of Speculation in the Recent Commodity Price Boom (and Bust)*, Journal of Agricultural and Applied Economics, 41,2(August 2009):377–391

ICSG (International Copper Study Group), *Chart 1: Trends in World Refined Stocks and Prices*, Lisbon 2012, http://www.icsg.org/index.php?option=com_content&task=view&id=57&Itemid=60, Retrieved 21 June 2012

ISCG, *The World Copper Factbook 2010*, Lisbon, 2010

ISDA Collateral Steering Committee, Market *Review of OTC Derivative Bilateral Collateralization Practices (2.0)*, 1 March 2010

Jickling M., *The Commodity Futures Modernization Act of 2000: Derivatives Regulation Reconsidered*, Report for Congress, Congressional Research Service, The Library of Congress, 29 January 2003

Jickling, M,. *The Enron Loophole*, CRS Report for Congress, 7 June 2008

Johnson L.L., *The Theory of Hedging and Speculation in Commodity Futures*, The Review of Economic Studies, Vol. 27, No. 3 pp. 139-151, June 1960

Kolb R. W., *Is normal backwardation normal?*, Journal of Futures Markets, 12: 75–91. 1992

Lagi M., Bar-Yam Y. (Yavni), Bertrand K.Z. and Bar-Yam Y. (Yaneer), *The Food Crises: A quantitative model of food prices including speculators and ethanol conversion*, New England Complex Systems Institute, Cambridge MA, USA, 21 September 2011 http://necsi.edu/research/social/food_prices.pdf, retrieved 25 November 2011

Lerner R.L., *The Mechanics of the Commodity Futures Markets: What They Are and How They Function*, Mount Lucas Management, June 2000

Leising M., *MF Global Suspended From Trading With N.Y. Fed*, Bloomberg, 31 October 2011, http://www.bloomberg.com/news/2011-10-30/corzine-s-mf-global-faces-pivotal-days-as-firm-considers-sale-bankruptcy.html, Retrieved 26 June 2012

Levin C., *Statement of Senator Carl Levin on the Close the London Loophole Act*, UN Senate, 12 June 2008, http://www.levin.senate.gov/newsroom/press/release/?id=dc568712-730d-4c88-9e8a-a217f7f61fcb, Retrieved 14May 2012

Lipton, E., *Gramm and the 'Enron Loophole'*, The New York Times, 14 November 2008, http://www.nytimes.com/2008/11/17/business/17grammside.html?pagewanted=all, Retrieved 14May 2012

LME.com, *History of the LME*, http://www.lme.com/who_ourhistory.asp, Retrieved 21 June 2012

LME.com1, *Ring Dealing: Category 1 – Ring Dealing*, http://www.lme.com/membership_ringdealing.asp, Retrieved 21 June 2012

LME.com2, *LME Free Data Service – Monthly Volumes*, https://secure.lme.com/Data/community/Dataprices_monthly_volumes.aspx (requires sign-in), Retrieved 21 June 2012

Mackrell International, *Legislators suggest changing the values of the market share for determining the undertaking's dominance on the market, and to review the control parameters for concentrations*, 27 October 2011, http://mackrell.net/2265-legislators-suggest-changing-the-values-of-the-market-share-for-determining-the-undertaking%E2%80%99s-dominance-on-the-market-and-to-review-the-control-parameters-for-concentrations, Retrieved 27 February 2012

Malkiel B.G., *The Efficient Market Hypothesis and Its Critics*, CEPS Working Paper No. 91, Princeton University, April 2003

Mandaro, L., CFTC moves to close 'London loophole', The Wall Street Journal – MarketWatch, 17 June 2008 http://articles.marketwatch.com/2008-06-17/news/30766598_1_position-limits-acting-chairman-walter-lukken-oil-contract Retrieved 14 May 2012

Market.view, *Searching for the naked truth: The real problem with abusive short-selling*, The Economist, 17 August 2008, http://www.economist.com/node/11951246/print?story_id=11951246, Retrieved 28 February 2012

Markham J.W., *Commodity Exchange Act (1936)*, Major Acts of Congress, Gale Cengage, 2004

Marx K., *A Contribution to the Critique of Political Economy*, Progress Publishers, Moscow, 1859

Masters M.W., and White A.K., *The Accidental Hunt Brothers: How Institutional Investors Are Driving Up Food and Energy Prices*, Christiansted VI, 31 July 2008

Moore P. and Khoja M., *A Case for Transparent Valuations of OTC Commodity Contracts in Tumultuous Times*, SunGard Kiodex, 2008

Moshinsky B., *Naked Short-Sellers, Derivatives Traders Face EU Restrictions*, Bloomberg, 15 September 2010, http://www.bloomberg.com/news/2010-09-15/naked-short-sellers-derivatives-traders-face-european-union-restrictions.html, Retrieved 28 February 2012

Nobelprize.org, *The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 1990: Harry M. Markowitz, Merton H. Miller, William F. Sharpe*, http://www.nobelprize.org/nobel_prizes/economics/laureates/1990/markowitz-autobio.html, Retrieved 22 February 2012

Northedge R., *130 Years of the LME*, London Metal Exchange: LME 130th Anniversary Supplement, London, 2007

OHCHR, *G-8 / EU: A global financial transaction tax, a human rights imperative now more than ever*, Geneva, 14 May 2012, http://www.ohchr.org/en/NewsEvents/Pages/DisplayNews.aspx?NewsID=12150&LangID=E, Retrieved 27 August 2012

Otto S., *A Speculative Efficiency Analysis of the London Metal Exchange in a Multi-Contract Framework*, International Journal of Economics and Finance Vol. 3, No. 1; February 2011

Otto S., *Personal Communication*, 13 January 2012

Paul A.B., *Speculative Position Limits*, Chicago Board of Trade, November 1980

Pellizzari P. and Westerhoff F., *Some effects of transaction taxes under different microstructures*, Journal of Economic Behavior & Organization 72 (2009) 850–863

Phillips PCB, Wu Y and Yu J (2009). *Explosive behavior in the 1990s NASDAQ: When did exuberance escalate asset values?*, Cowles Foundation for Research in Economics, Yale University.

Phillips P.C.B. and Yu J., *Dating the Timeline of Financial Bubbles During the Sub-Prime Crisis*, Quantitative Economics 2 455-491, 2011

Pirrong, C., *Squeezes, Corpses, and the Anti-Manipulation Provisions of the Commodity Exchange Act*, Regulation Vol. 17 No. 4, © 1994 by the Cato Institute, http://www.cato.org/pubs/regulation/regv17n4/reg17n4c.html, Retrieved 16 January 2012

Price M., *Mifid II: in a nutshell*, Dow Jones Financial News, 21 Oct 2011, http://www.efinancialnews.com/story/2011-10-21/mifid-two-in-a-nutshell, Retrieved 14 May 2012

Reuters.com, Factbox: *Flash crashes and HFT in commodity markets*, 17 June 2011, http://www.reuters.com/article/2011/06/17/us-commodities-highfrequency-fb-idUSTRE75G0MY20110617, Retrieved 30 January 2012

Robles M., Torero M. and von Braun J., *When Speculation Matters*, IFPRI Issue Brief 57, February 2009

Sachs J., Tornell A. and Velasco A., *Financial Crises in Emerging Markets: The Lessons from 1995*, Harvard University, Paper No. 97-1, January 1997

Scheid B., *The Barrel: Are swap dealer limits so high they're no longer limits?*, Platts.com, 19 April 2012, http://www.platts.com/weblog/oilblog/2012/04/19/are_swap_dealer.html, Retrieved 15 May 2012

SEC, *Division of Market Regulation: Key Points About Regulation SHO*, 11 April 2005, http://www.sec.gov/spotlight/keyregshoissues.htm, Retrieved 28 February 2012

Seth A., *Granger causality*. Scholarpedia, 2(7):1667, 2007, http://www.scholarpedia.org/w/index.php?title=Granger_causality&action=cite&rev=91329, Retrieved 22 August 2012

Sheppard D., *Obama oil margin plan could increase price swings*, Reuters, 20 April 2012, http://www.reuters.com/article/2012/04/20/us-obama-cftc-margins-idUSBRE83I1FO20120420, Retrieved 27 August 2012

Shumsky T. and Cui C., *Trader Holds $3 Billion of Copper in London*, Wall Street Journal, 21 December 2010, http://online.wsj.com/article/SB10001424052748704118504576034083436931412.html, Retrieved 29 November 2011

Sornette D. and von der Becke S., *Crashes and High Frequency Trading: An evaluation of risks posed by high-speed algorithmic trading*, UK Government Office for Science, August 2011

Stafford P., *CME wins reprieve on CFTC margin rules*, ft.com>Markets>FT Trading Room, 4 May 2012, http://www.ft.com/intl/cms/s/0/d64ec1fe-95c4-11e1-a163-00144feab49a.html#axzz24kHGEzIy, Retrieved 27 August 2012

Stoll H.R. and Whaley R.E, *Commodity Index Investing and Commodity Futures Prices*, Vanderbilt University Nashville, September 2009

Tang K. and Xiong W., *Index Investment and Financialization of Commodities*, Renmin University of China, Princeton University and NBER, March 2011

Taylor M. and Desai P., *JPMorgan denies it holds 90 pct of LME copper stocks*, Reuters, London, 14 December 2010, http://www.reuters.com/article/2010/12/14/us-lme-copper-idUSTRE6BD3RV20101214, Retrieved 29 November 2011

Thomas S., *Analysis: LME single but happy amid exchange merger fervor*, Reuters.com, London, 31 March 2011, http://www.reuters.com/article/2011/03/31/us-lme-independence-idUSTRE72U21G20110331, Retrieved 30 January 2012

Thomas D. and Thomas S., *HK bourse agrees to buy London Metal Exchange*, Reuters, 15 June 2012, http://uk.reuters.com/article/2012/06/15/lme-hkex-idUKL3E8HF31V20120615?feedType=RSS&feedName=rbssEnergyNews, Retrieved 21 June 2012

Thornton D.L and Batten D.S., *Lag Length Selection and Granger Causality*, Working Paper 1984-001A, Federal Reserve Bank of St Louis, 1984

Tilton J.E., Humphreys D. and Radetzki M., *Investor demand and spot commodity prices*, Resources Policy 36, pp187–195, 2011

Times Topics, Financial Regulatory Reform, New York Times, 20 September 2011, http://topics.nytimes.com/topics/reference/timestopics/subjects/c/credit_crisis/financial_regulatory_reform/index.html, Retrieved 14 May 2012

Tobin J., *A Proposal for International Monetary Reform*, Cowles Foundation Discussion Papers 506, Cowles Foundation for Research in Economics, Yale University. 1978

Trochim W. and Donnelly J.P., *The Research Methods Knowledge Base (3rd Edition) – The T-Test*, Atomic Dog Publishing, December 2006

UNCTAD, *Global Initiative on Commodities Report*, Brasilia, May 2007, UNCTAD/DITC/COM/2007/6

UNCTAD Secretariat Task Force on Systemic Issues and Economic Cooperation, *The Global Economic Crisis: Systemic Failures and Multilateral Remedies*, New York and Geneva, 2009 ISBN 978-92-1-112765-2 http://www.unctad.org/en/docs/gds20091_en.pdf, Retrieved 15 December 2011

UNCTAD (2009a), *Trade and Development Report 2009*, New York and Geneva, 7 September 2009

UNCTAD, *Price Formation in Financialized Commodity Markets: The Role of Information*, New York and Geneva, June 2011

UNEP, *Metal Stocks & Recycling Rates*, 2011

USGS (US Geological Society), *Mineral Commodity Summaries – Copper*, January 2012

USSSI (Permanent U.S. Senate Subcommittee on Investigations), *Excessive Speculation in the Wheat Market: Executive Summary*, 24 June 2009

USSPSI (US Senate Permanent Subcommittee on Investigations: Homeland Security and Governmental Affairs Committee), *Press Release: Investigations Subcommittee Holds Hearing on Excessive Speculation and the New Positions Limit Rule*, 2 November 2011, Washington DC

Vestas, *An environmentally friendly investment: Lifecycle Assessment of a V90-3.0 MW onshore wind turbine*, Denmark, 2006

Wessa P., *Bivariate Granger Causality (v1.0.0) in Free Statistics Software (v1.1.23-r7)*, Office for Research Development and Education, 2008 http://www.wessa.net/rwasp_grangercausality.wasp/, Retrieved 15 May 2012

Williams J.C., *Manipulation on Trial: Economic Analysis and the Hunt Silver Case*, Cambridge University Press, 1995

World Bank, *Global Economic Prospects: Maintaining Progress amid turmoil,* Volume 3, June 2011

World Commission on Environment and Development, *Our Common Future*, Oxford University Press, Oxford & New York, 1987

Yglesias M., *JP Morgan Loses $2 Billion in Massive Failed Effort to Exploit Volcker Rule Loophole*, Slate: Money Box, 10 May 2012, http://www.slate.com/blogs/moneybox/2012/05/10/jp_morgan_volcker_loophole.html, Retrieved 15 May 2012