AN ANALYSIS OF THE IMPACT OF FINANCIALISATION ON COMMODITY FUTURES AND SPOT PRICES

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DECLARATION OF ORIGINAL WORK

This page is to declare that the work in this thesis is my own and was completed as part of the Degree of Master of Economics at Rhodes University.

Any work which was is not of my own has been credited and cited accordingly.

This thesis has not been submitted to any other university or college for degree purposes.

Signed: Geoffrey Calitz

Date: 01/01/2025

ABSTRACT

The debate on the commodity financialisation phenomenon was triggered in response to the steep rise in commodity futures and spot prices during the 2000-2011 super cycle. The two schools of thought regarding the underlying causes of such dramatic price increases are divided between those attributing the super cycle to fundamental drivers, and those who suggest that fundamental drivers alone are an insufficient explanation, and that other non-fundamental drivers are important. Fundamental drivers commonly cited in the literature include the sustained growth in demand for commodities throughout the early 2000s from emerging economies, such as China and India, and shocks to supply chains such as crop failures, export bans, and other factors such as macroeconomic dynamics. However, an alternative school of thought found empirical evidence which suggested that in addition to fundamental drivers, non-fundamental drivers such as key regulatory changes in commodity and financial markets in 1999/2000, and the subsequent changes to the trading activities in commodity derivative markets and the resultant historic growth in the participation of purely financial investors, significantly impacted the structure and price dynamics in commodity markets, in a phenomenon known as the financialisation of commodity markets.

This study contributes to the empirical literature by expanding compared with previous studies the time period under investigation, as well as expanding the range of commodities examined. The most recent 2020-2024 period of rising prices is included, and the behavior of both cross-sector and same-sector pairwise return correlations of futures and spot prices in this period is compared to the pre-financialisation period. The study contributes to the literature by examining how the cross market and cross asset return correlation structure has behaved throughout the entire post-financialisation era. The study makes a further contribution by establishing the statistical significance of futures market returns as a predictor of spot market returns.

It is found that the financialisation phenomenon impacted both commodity futures and spot markets. Pairwise return correlation is substantially greater throughout Period 2 (post-financialisation) compared to Period 1 (pre-financialisation) for same-sector and cross-sector pairs of futures and spot prices. The structural change in return correlation between these two periods was found to be especially pronounced for cross-sector pairs of futures and spot prices. The financialisation hypothesis is further supported by the findings of persistent structural changes in cross market and cross asset return correlation, which has become even more

pronounced in the later stages of financialisation. The most recent period of rising commodity prices, Period 2(c) (2020-2024), is found to show elevated pairwise return correlation for futures and spot prices levels when compared to Period 1 (pre-financialisation), but the increase in correlations is less than in earlier financialisation periods such as Period 2(a) (2000-2011) and Period 2(b) (2012-2019). These findings suggest that index buying may be less important in the later stages of commodity financialisation. It was found that futures market returns are statistically significant predictors of spot market returns. Furthermore, the causal effect of futures market returns on spot market returns under the effect of financialisation (2000-2024) is found to be statistically significant in all five examples (WTI crude oil, gold, silver, LME copper and aluminium) examined in the study.

The study finds that a clear structural change occurred in commodity spot and futures markets in the post-financialisation period. The consistency of this structural change is evident when analysing both cross sector and same sector pairwise return correlation behavior of commodity spot and futures prices, and when analysing cross market and cross asset return correlation between commodity markets and financial market benchmarks. The implication for investors is that commodity markets no longer offer certain portfolio diversification benefits and downside protection to drops in equity markets previously found in the empirical literature, and investors need to recalibrate strategies to account for these structural changes.

The study concludes that the commodity market financialisation hypothesis is sound, and this implies that further research is required to better understand the impact of such structural changes on commodity futures and spot markets. In addition, because futures market returns are found to be a statistically significant predictor of spot market returns, it is imperative that further research be undertaken which investigates the explicit relationship between futures and spot markets so that policy makers and market regulators better understand the links between these two markets so that policy decisions are better informed. Furthermore, it is necessary that future research investigates how the transmission of information occurs between futures and spot markets, and how this matters for consumers, and addresses what welfare implications may be associated with this. Lastly, the author has advocated for increased transparency and restrictions in commodity markets, suggesting that all trading occurs on open regulated exchanges and that position limits are implemented, so as to prevent any market distortion which may come from institutional speculators taking excessively powerful and large positions.

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. . .

“Trust in the Lord with all your heart, and do not lean on your own understanding. In all your ways acknowledge Him, and he will make straight your paths.” Proverbs 3: 5 - 6

“Do not be afraid or discouraged, for the Lord will personally go ahead of you. He will be with you; he will neither fail you nor abandon you.” Deuteronomy 31: 8

“Many are the plans in a person’s heart, but it is the Lord’s purpose that prevails.” Proverbs 19: 21

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CHAPTER 1:

INTRODUCTION

1.1. Background to the Study

Commodities are raw materials traded in spot and derivative (futures) markets. These markets exist to provide physical commodity producers and consumers with accurate, uniform, and publicly known prices and contract terms for the immediate or future delivery of specific commodities (Chang, 1985). The spot market is the physical market, where participants trade commodities for immediate delivery. In derivative markets, participants hold the right (‘options’) or obligation (‘futures’) to trade physical commodities at some point in the future at a specified price and quantity (Staritz, 2012). These markets allow participants to trade based on expectations for supply and demand patterns (CEPS, 2013). Derivative contracts may be traded within regulated derivative exchange markets, known as the futures markets, or in a less regulated fashion, referred to as ‘over the counter’ (OTC) (Staritz, 2012). Futures markets allow market participants to secure a specific price of commodities in advance of its real production and availability (Pirrong, 1994). Futures markets provide commercial spot market participants with a price discovery function, and the futures market prices provide pricing benchmarks which inform spot market transactions and decision making (Staritz, 2012). Futures markets facilitate open market price discovery of commodities (Ndawona *et al,* 2019). They also provide spot market participants with an insurance function, as futures contracts are often used as a means of hedging against potential future pricing fluctuations, or other future events (Staritz, 2012).

After more than two decades of subdued commodity prices, commodity markets experienced a very strong price super cycle beginning in the 2000s, first peaking in 2008, and again in 2011. The boom was unprecedented in both its length and magnitude, as well as the wide range of commodities whose prices rose. For this reason, the 2000-2011 commodity boom was thereafter often referred to as a “super-cycle”. The price declines from the first peak around the middle of 2008 after the onset of the global financial crisis, and again after the 2011 peak, likewise stood out for their sharpness and the breadth of commodity prices which were negatively affected (UNCTAD, 2011). From the 2011 peak to 2015-16, commodities prices in all major sectors fell by 40% (World Bank, 2016). The acute nature of such price fluctuations, as well as the synchronized increases (Tang and Xiong, 2012) and subsequent declines across all major commodity types (Mann and Keeton, 2013, Ndawona *et al,* 2019), prompted research into the underlying causes of such outcomes.

Some authors attributed the 2000-2011 commodity boom to the growing demand for commodities in very large developing regions that were growing rapidly, namely India and China. According to UNCTAD (2011), commodity-intensive infrastructural development associated with urbanization and industrialization, as well as changing dietary preferences in these countries towards more protein rich options, sustained strongly growing demand for key commodities. Akram (2009) emphasized additional macroeconomic factors at that time, such as a lower interest rate environment and a weakening US dollar, as also being partly responsible for driving commodity prices higher. Krichene (2008) adds that the loose monetary policy stances in the early 2000s were also a driver of higher commodity prices. On the supply side, Radetzki (2006) and Humphreys (2009) highlight the lagged supply side responses to increased demand inherent in capital-intensive mining and metals industries, combined with low investor confidence to invest in production expansion in the years preceding the commodity boom, as key supply-side factors which also drove prices higher.

On the other hand, many authors such as Masters (2008), De Schutter (2010), Tang and Xiong (2012), and Mann and Keeton (2013), expressed concerns that macroeconomic and fundamental commodity drivers alone could not explain the strength and abnormally synchronised price movements across such a broad spectrum of commodities. Prior to the early 2000s, although there was easy access to highly liquid commodity futures contracts being traded on major exchanges, commodity prices offered a risk premium for an individual commodity's price risk (Bessembinder, 1992, de Roon, Nijman and Veld, 2000), where commodity prices were also known to have very little co-movement with equities (Gorton and Rouwenhorst, 2005), and there had been little co-movement amongst the prices of various commodities (Erb and Campbell, 2006). As noted by Tang and Xiong (2012), these price dynamics are the opposite to what is observed of generic financial assets, which have inherent systemic risk, known to exhibit substantial co-movement with both market indices and between each other. Indeed, these contrasting market dynamics suggest that commodity markets were previously segmented from peripheral financial markets and from other commodity markets.

Two key deregulatory events caused changes to the trading activity within commodity derivative markets, thereafter, permanently altering the fundamental microstructure and traditional functioning of these markets (Shanmugam and Armah, 2017). The Gramm-Leach-

Bliley Act in the US in 1999 (known as the Financial Services Modernization Act) had granted commercial banks, investment banks, securities firms, and insurance firms the ability to consolidate and act as any combination of the above (Shanmugam and Armah, 2017). In the same year, the US Congress passed legislation which prevented the US Commodity Futures Trading Commission (CFTC) from regulating OTC commodity derivatives. Thirdly, in 2000, the rollout of the Commodity Futures Modernization Act authorized the complete exemption of the CFTC's oversight of trading in energy derivatives, OTC swaps and other commodity derivatives (Shanmugam and Armah, 2017). It was soon after this that wide recognition was given to the discovery and publication that there historically a low and negative correlation existed between commodity market returns and equity market returns, first noted by Greer (2000), then later confirmed by Gorton and Rouwenhorst (2005), and Erb and Campbell (2006). The initial discovery by Greer (2000) gave financial institutions a theoretical greenlight to begin promoting commodities, and commodity futures, as a new asset class, by highlighting potential yield, hedging characteristics and portfolio diversification benefits. Several authors (Falkowski, 2011, Mann and Keeton, 2013, Masters, 2008, Shanmugam and Armah, 2017, Tang and Xiong, 2012) have published findings to support the notion that the commodity futures markets deregulation by the end of 1999 coincided with the emergence of commodity futures becoming a popular asset class amongst financial institutions and with commodity prices broadly beginning to rise in the 2000s. Subsequently, billions were injected within commodity futures markets by institutions such as money managers, global pension funds and hedge funds. As a result, the value of commodity markets has since seen substantial growth within the last three decades. The average annualised trade volumes in the U.S. commodity futures markets rose from 2.1 trillion dollars between 1990 and 1999, to 7.6 trillion dollars between 2000-2009, and 14.1 trillion dollars between 2010-2019 (Kang, Tang and Wang, 2023). Remarkably, in 2021 alone, the annual trade volumes in the U.S. futures markets rose to a new high of 40.6 trillion dollars (Kang, Tang and Wang, 2023).

The rapid growth of investor interest to participate in commodity futures markets around the 2000s was mainly satisfied by purchasing commodity indices investments, namely the Standard and Poor Goldman Sachs Commodity Index (S&P GSCI) and the Dow Jones Commodity Index, as opposed to purchasing individual commodities. Commodity indices are an efficient vehicle for investors seeking well diversified allocations to the commodity (futures) market, as the index is a weighted basket consisting of the primary commodity futures in the US. A 2008 report (CFTC, 2008) found the overall value of investment in commodity indices held by institutions had grown from 15 billion dollars in 2003 to approximately 200 billion dollars by the middle of 2008. This led many observers and policy makers to express strong concern that growing interest in speculative commodity index investments may have driven the rapid price increases of many food and energy commodities which occurred during 2007 and 2008 (De Schutter, 2010, Tang and Xiong, 2012). Indeed, in 2008, Michael Masters, a prominent hedge fund portfolio manager, testified to the US Senate and the US CFTC, claiming that it was the large injections of speculative institutional investment into commodity futures markets catalysed the extreme 2007-2008 spike in prices in the futures and spot markets (Masters, 2008). Masters (2008) accused the new institutional investors of retrofitting capital market investment strategies to speculate in and disrupt markets which exist to benefit the *bona fide* physical (spot) commodity producers and users (Masters, 2008).

What was termed 'The Masters Hypothesis', is said to have been the catalyst of a highly contested debate (Irwin and Sanders, 2011) which continues to this day. However, many would agree that a seminal study, by Tang and Xiong (2012), was even more of a catalyst. In this study, it was found that the rapid inflow of speculators and commodity index investors into the commodity futures markets around the early 2000s promoted a substantial positive rise in cross-market return correlation between commodity and equity markets, a phenomenon thereafter referred to as "the financialisation of commodity markets" (Tang and Xiong, 2012). This finding is in sharp contrast to earlier findings which suggested commodity and equity markets were negatively correlated (Greer, 2000, Gorton and Rouwenhorst, 2005), which had served as the theoretical basis which captured the attention of institutional investors and initiated the recognition of commodities as a value-add to portfolios and a means of strategic diversification in the first place. Importantly, Tang and Xiong (2012) findings suggest the commodity financialisation process also had substantial impacts on pairwise return correlation structures both between and within indexed and non-indexed commodity futures.

Since this seminal publication (Tang and Xiong, 2012), more research has been published, which explores the impacts of financialisation on the commodity futures and spot markets. The discourse may be broadly divided between those claiming a direct link exists between 'non-fundamental' drivers such as the historic commodity futures market deregulation in 1999/2000, subsequent commodity market financialisation, and the 2000-2011 boom in commodity futures and spot prices, and those disputing these claims, insisting that the 2000-2011 super cycle is explainable in terms of 'fundamental' drivers, and rejects that financialisation is distortive.

The first group (Masters, 2008, De Schutter, 2010, Tang and Xiong, 2012) calls for stronger regulatory, policy and research responses considering the claims and findings that the 1999-2000 commodity futures deregulation and the rise of commodity index speculation, distorts the commodity markets. Tang and Xiong (2012) tested for pairwise rolling return correlations of daily future prices during the 2000-2011 super cycle and found increasingly positively return correlations for pairs of indexed agricultural and energy commodity futures in the post-financialisation period compared to low and mostly insignificant return correlation in the pre-financialisation period. They attributed this to the fact that institutional buyers buy all the index weighted commodity futures when investing in a commodity futures index, as opposed to investing in an individual commodity.

Mann and Keeton (2013) extended this work by analyzing relationships of commodity prices amongst traded metals and Brent crude oil for the 2000-2011 period. They, too, found that the returns of these unrelated indexed commodity futures prices were now much more highly correlated in the post-financialisation period versus the pre-financialisation period, and the same could not be found for bulk commodities which are not weighted in any prime commodity index (Mann and Keeton, 2013). Basak and Pavlova (2015) findings suggest that when institutional capital inflows flow into commodity markets, the futures prices of all commodities rise, but that during the 2000s commodity super cylcle, the prices of indexed commodity futures increased significantly more than non-indexed futures. Indeed, Bohl and Stephan (2012) highlighted that despite index speculation not directly influencing the physical demand for commodities, index speculators can create a distortion of spot market price behavior in an indirect way, as spot prices are related to futures market price via the arbitrage channel. Findings from Mathews (2012), Hernandez and Torrero (2010), and Tilton *et al* (2011) suggest the informational flows from futures markets to spot markets have gained significant momentum since the early 2000s.

Ndawona *et al* (2019) confirm previous findings (Tang and Xiong, 2012, Mann and Keeton, 2013) that the returns of indexed futures and the returns of spot commodities with indexed futures counterparts were more highly correlated during the 2000-2011 post-financialisation period compared to the pre-financialisation period. It was also found that return correlations fell during the 2011-2015 period, when both commodity prices and commodity investment buying by institutions declined sharply, although the return correlation remained still significantly higher than in the pre-financialisation period (Ndawona *et al*, 2019). Furthermore, Ndawona *et al* (2019) found Granger causality results provided evidence of futures market prices leading the spot market price during the 2000-2011 commodity boom, and the relationship changed to bi-directional when prices and return correlations fell in the 2011-2015 period of falling prices. More recently, Kang, Tang and Wang (2023) found that in the post financialisation period of 2004-2021, commodity financialisation drove a substantial rise in cross-market return correlations between commodity and equity markets. More so, Kang, Tang and Wang (2023) found that post-commodity financialisation, the significance and influence of non-commercial (i.e. non-physical participant in the commodity markets) traders is elevated, and the pairwise return correlation amongst indexed futures remains high and, in many cases, continues to rise, throughout the post-financialisation period. Kang, Tang and Wang (2023) conclude that these post-financialisation effects become increasingly more harmful to the fundamental functions of commodity futures markets.

The second group of analysts (Stoll and Whaley, 2010, Irwin and Sanders, 2011) acknowledge that the financialisation process may have had an effect in the 2000-2011 commodity price super cycle but insist that fundamental price determinants (demand/supply) and macroeconomic influences at the time were the primary drivers. Research by authors in this camp find that the financialisation process did not have an impact on commodity price volatility (Buyuksahin and Harris, 2009, Dwyer *et al*, 2011, Philips and Yu, 2010). Fattouh *et al* (2012) insist that no empirically proven relationship exists to link futures prices and spot prices, and suggest that because financialisation happened in the futures markets, and there was no way it would have spilled over into spot market prices, and so no additional regulatory responses are justified.

1.2. Goals of the Research

The study intends to contribute to the existing body of research covering the impact of commodity financialisation on both futures and spot markets and contribute to the empirical work on the relationship between commodity futures and spot prices. The study extends previous analyses by adding the period of a broad-based commodity price upswing which began in 2019/2020, until April 2024. It complements previous research (Tang and Xiong, 2012, Mann and Keeton, 2013, Ndawona *et al,* 2019) by expanding the range of commodities examined to include futures prices for the grains, livestock, softs, energy, industrial metal and precious metal sectors, and spot prices for the energy, industrial metal and precious metal sectors. This area of research has important policy implications, as excessive commodity price volatility has adverse microeconomic and macroeconomic effects. Greater price volatility has a more heightened impact on the macroeconomy and public finances of commodity producing countries, while, at the microeconomic level, commodity price uncertainty stifles prospective investment into unlocking additional commodity supply, and dampens longer-term commodity production growth (UNCTAD, 2011). Importantly, it is the low-income and food-insecure developing regions who rely on basic commodity imports such as food and fuel, which feel the brunt of basic food and energy price spikes like that of 2007/8 (De Schutter, 2010). Higher prices of these basic commodities have a direct impact on food and energy security, as well as political and social stability (Staritz, Heumesser and Kublbock, 2013).

The primary goal is to expand the research into the effects of commodity market financialisation on commodity futures and spot markets. To achieve this, the following sub-goals are to be met:

1. Expand the period under investigation and establish whether the increasing return correlation found amongst commodity spot prices and amongst futures prices during the 2000-2011 commodity boom can again be found in the most recent sharp rise in commodity prices in the 2020-2024 period. The results are compared to the pre-financialisation (1994-1999) period.
2. Revisit the 2000-2011 and 2012-2019 post-financialisation sub-periods, and using the same rolling return correlation method, establish whether previous research findings for food and oil commodities (Tang and Xiong, 2012), and industrial metals and oil (Mann and Keeton, 2013, Ndawona *et* al, 2019), can also be found when expanding the range of commodities examined to include other commodity sectors. Indexed and non-indexed commodities are included. The results are compared to the pre-financialisation (1994-1999) period.
3. Examine, firstly, how the cross-market return correlation structure of commodity and equity markets, and secondly, how the cross-asset return correlation of commodity markets and investor sentiment indices, has behaved throughout the entire post-financialisation (2000-2024) period, and its sub-periods, including the 2020-2024 price upswing. The results are compared to the pre-financialisation (1994-1999) period.
4. Establish, by means of a multiple regression analysis, whether, and to what extent, futures market returns can explain and predict spot market returns and conclude whether the results are statistically significant.
5. Explore the policy implications of the findings.

1.3. Methods, Procedures and Techniques

Quantitative analysis is utilized as the principal method of research. The research paradigm is positivist. This paradigm is appropriate for an investigation aiming to establish a cause-and-effect relationship through data analysis (Kivunja and Kuyini, 2017). Rolling return correlations are calculated for daily settlement prices of US traded commodity futures. Rolling return correlations are also calculated for daily closing spot prices which have indexed commodity futures counterparts, and those that do not. Data used in the analysis was accessed through the Thompson Reuters (Eikon) 'Datastream' online database.

Informed by Bicchetti and Maystre (2012), Tang and Xiong (2012), Mann and Keeton (2013) and Ndawona *et al.* (2019), the first sub-goal is achieved by calculating the rolling return correlation for i) exchange traded commodity futures (industrial metals, food and agricultural commodities, energy commodities and precious metals), ii) spot prices of exchange traded commodities (industrial metals, energy commodities and precious metals), iii) futures prices and the corresponding spot prices for commodities which are not part of commodity indices (i.e. non-indexed commodities). The results determine whether previously found increasingly correlated returns across food, energy and industrial metal prices in the 2000-2011 commodity boom was repeated in the most recent upward price cycle between 2020-2024, and the results are compared to that in the pre-financialisation (1994-1999) period.

The motivation behind the use of the rolling return correlation method is that if financialisation and the popularization of index investing in the early 2000s impacted and continues to impact commodity prices, then the prices of unrelated indexed commodity futures, and spot prices with indexed futures counterparts, will on average be more highly correlated in the 'post-financialisation' (2000-2024) period compared to the 'pre-financialisation' (1994-1999) period. This is because when financial institutions engage in speculate or passive commodity index investing, commodity index futures are bought, and funds are proportionately distributed according to the relative weightings of each commodity as per the index construction. It is therefore expected that, given the theoretical link between futures and spot markets, that the returns of unrelated commodity spot prices with indexed futures counterparts will also be found on average to be more highly correlated throughout the 'post-financialisation' period.

To achieve the second sub-goal, the range of commodity prices and sectors included in the analysis is expanded. In addition, the study compares returns of both indexed and non-indexed commodities, as the latter are not expected to be (as) highly correlated with other indexed commodities as they are not bought when investors buy a commodity index.

To achieve the third sub-goal, the S&P GSCI is used as a proxy for commodity market returns. The cross-market return correlation structures between commodity market returns and global equity market returns, and cross-asset return correlation structure between commodity market returns and investor sentiment indices such as a US 10 Year Treasury Index and the US Dollar Index, are examined.

To achieve the fourth sub-goal, a multiple regression analysis is used to examine the relationship between futures market returns and spot market returns. Spot market returns are the dependent variable, and futures market returns, as well as the other variables, are explanatory variables. It is assumed that in the presence of commodity market financialisation, index investment and speculative institutional activity in the futures markets, there is risk of a spillover effect into the spot markets. The assumption is centered on the fact that spot and futures markets are theoretically linked, and because spot market participants are inherently reliant on accurate prices and information originating from the futures markets to inform decision making, and these commercial spot market participants rely on the futures markets to be able to accurately inform and facilitate hedging and insurance functions.

It is therefore important to statistically establish whether, and to what extent, futures market returns can explain and predict spot market returns by means of regression analysis. It is important because one of the key disputes within the commodity market financialisation literature is between those who suggest activity in the futures markets does in fact impact and spillover into the spot market, and then those who either deny that there is any questionable activity in the futures market at all or argue that what happens in the futures markets stays in the futures markets and the spot market is unaffected. As divided as the body of research may be, the theoretical links between the futures and spot market, and the critical functions that futures markets are intended to facilitate for the spot market participants, provide ample justification for further research.

The final subgoal goal will be achieved by examining the policy implications found in the empirical literature and presenting the author's own policy proposals.

1.4. Outline of the Study

This study is structured in the following way: Chapter 2 is a review of the theory and the empirical literature on commodity markets and commodity financialisation. Chapter 3 is an overview of the data, data sources and the methodology employed in the study. Chapter 4 discusses the results and empirical outcomes of the study. Chapter 5 is a discussion of the implications for policy and future research. Chapter 6 is the conclusion of the study, where the main findings and policy implications are summarsied.

CHAPTER 2:
LITERATURE REVIEW

2.1. Introduction

Commodities are a vital component to the world economy. The twenty-first century has witnessed commodity markets become increasingly more "financialized", that is, increasingly impacted by speculative purchases and sales rather than just physical transactions. The difficulty in explaining the 2000-2011 commodity price super cycle solely in terms of 'fundamental' demand and supply drivers has led a growing body of research to reconsider the 'non-fundamentals' at play during the historic boom-bust cycle. Changes to 'fundamental' demand and supply drivers during the super cycle are widely recognized, both leading up to and during the 2000-2011 period, such as large increases in the demand for commodities from the fast-growing economies of China and India, growth of alternative energy production using commodities, changing dietary trends, and lagging supply side responses (Staritz, 2012). However, it has been argued that 'fundamental' drivers alone are an insufficient explanation for the extreme price volatility and unusually synchronized nature of the boom-and-bust cycles which affected most commodities in 2007, 2008 and 2011 (Cheng and Xiong, 2014, Staritz, 2012). In particular, the rise in price volatility throughout the super cycle period raised concerns pertaining to the fundamental organisation of the commodity futures and spot markets (CEPS, 2013). Indeed, alongside the 'fundamental' drivers, 'non-fundamentals' such as the historical deregulation of commodity futures markets in 1999/2000, key empirical publications highlighting the benefits of portfolio exposure to commodities, and the subsequent dramatic growth of financial institutional interest in commodity futures indices and derivatives trading, need to be factored into the analysis (Dwyer, Gardner and Williams, 2011).

The increased participation of financial and institutional players was said to have permanently altered the microstructure and price dynamics of commodity derivative markets (Ndawona *et al*, 2019). This contemporary treatment of commodity markets as some form of a financial market asset has since garnered a growing academic and political interest concerned with the extent to which commodity futures and spot prices are in fact reflective of underlying demand and supply 'fundamentals' versus the increasingly

financialised nature and ‘non-fundamental’ treatment of these markets (Dwyer, Gardner and Williams, 2011).
This literature review introduces commodity markets and the accompanying economic theory. The concept of commodity market financialisation is explored, and the active discourse surrounding this modern phenomenon is examined in detail. The research, methodologies, and the empirical findings from both sides of the debate are reviewed.

This chapter is structured in the following way: Section 2.2 covers the functioning and purpose of commodity futures and spot markets. Section 2.3 introduces the main participants in commodity markets and their strategies. Section 2.4 is a review of the theory of commodity price formation. Section 2.5 discusses the established theory and the empirical findings on the relationship between spot and futures prices. Section 2.6 introduces the different forms of commodity market trading. Section 2.7 reviews historical commodity market regulation and features the key regulatory changes which took place in 1999/2000 and highlights some recent legislative action. In Section 2.8 the concept of commodity market financialisation is introduced. Section 2.9 introduces the theory surrounding commodity market cyclicality and super cycles, and while some historical examples of super cycles are discussed, there is an emphasis on the 2000-2011 super cycle and its consequences. Section 2.9 introduces some of the explanations from the empirical literature as to what exactly were the ‘fundamental’ and ‘non-fundamental’ drivers of the 2000-2011 super cycle. Section 2.10 describes the commodity market trends and some empirical findings post-2011. Section 2.11 concludes.

2.2. Commodity Market Structure and Functioning

2.2.1. Introduction to Commodity Markets

Commodity markets are vital to the longer-term viability of the world economy. Commodity markets directly and indirectly shape our daily decisions. Unlike financial markets, centralised commodity futures markets exist to provide the commercial producers and consumers of commodities with publicly available, standardised pricing and contractual specifications (Chang, 1985). Commodities in these markets are of a standardized and verifiable quality and are commonly traded worldwide in competitive markets (CEPS, 2013). All commodities have unique sets of traits, for example, natural deposits and availability, production requirements, production yields, storage requirements, transportability, substitutability, and so on. For example, some agricultural commodities, such as Maize, are renewable, yet are subject to structural supply constraints, which may fuel seasonal price swings associated with limited annual production or set harvest windows. Supply characteristics may impact elasticity of demand if there are limited substitutes available, for example crude oil (CEPS, 2013). Specific characteristics, like long-term storability or alternative use cases, are important factors influencing markets. There are a multitude of factors driving commodity market trends. Endogenous factors are primarily linked to how a commodity is produced, whereas specific demand and supply characteristics, as well as other external forces, expose a commodity to a host of exogenous factors. Exogenous factors may include policy, weather events, relative currency fluctuations, freight capacity, storage disruptions, and so on.

There is a wide-ranging set of characteristics and variables affecting the way commodities are traded in markets. Indeed, with commodity markets being so heavily dependent on exogenous variables, along with the inherent instability of demand and supply, this has made commodity markets historically volatile (Cashin and McDermott, 2002). Commodity markets, in theory, are providing information reflective of demand and supply conditions (Pirrong, 1994). Commodity markets are, at any point in time, pricing in a wide spectrum of demand and supply complexities and context specific factors. Market participants may choose to use public or private commodity market information to buy, sell, or make decisions about resource allocation and investment (Pirrong, 1994).

In the last three decades, the confluence of many factors such as deregulatory action, rapid technological advances and innovations have driven the contributed to global financial markets becoming more integrated (Amar, Goutte, Isleimeyyeh and Benkraiem, 2022). Financial and the commodity market now operate ‘around the clock’. The increasingly ‘financialised’ nature of commodity markets throughout the previous three decades has arguably strengthened the financial integration across these markets, amplifying the extent and pace by which shocks manifest and spread throughout markets (Adams and Gluck, 2015, Cheng and Xiong, 2014). In addition to this, the growing presence of financial investors in commodity markets has been found to have increased the integration and connectedness between commodity markets (Tang and Xiong, 2012, Basak and Pavlova, 2015). Understanding modern day cross-market financial integration and the connectedness among commodity markets is important from the point of view of a regulator, as it implies greater systemic risk (Benoit, Colliard, Hurlin and Perignon, 2017).

2.2.2. Overview of Spot Markets

There are two primary commodity markets, consisting of the physical (spot) cash market and the futures (derivatives) market. The physical market tries to balance actual commodity supply and demand (CEPS, 2013). Actual producers and users trade commodities in this market, and are referred to as the spot market participants. In this market, spot contracts are traded with the expectation that buyers and sellers of commodities are to fulfill their commitments promptly and with immediate effect. Alternatively, futures contracts are traded based on an agreement amongst the buyers and sellers to lock in a price today and punctuate the transaction with the commodities physically delivered at a future time, if the contract is completed (Mathews, 2012). Indeed, commodity futures markets provide a means of making intertemporal choices, for example an end user wishes to make trading decisions today based on future demand and supply expectations (CEPS, 2013).

The spot market, comparatively, digests the buying and selling interests of the physical commodity today, subject to the immediate availability of inventories (CEPS, 2013). The spot price reflects the prevailing price for a commodity available for immediate delivery. Considering this, spot prices are therefore influenced by the current equilibrium of supply and demand for the physical commodity, as this is a direct driver of changes to available inventories (CEPS, 2013). In a competitive commodity spot market, the purchase and sale of commodities occur at a price referred to as the ‘spot price’, or ‘cash price’, but because inventory holdings change over time, the spot price does not just reflect today’s consumption and production (Pindyck, 2001). Instead, the spot market can be characterised by the interaction between the prevailing spot market prices and ‘net demand’, or the put differently, difference between current production (supply) and consumption (demand) (Pindyck, 2001). Inventories are an important buffer against market price volatility and disruptive exogenous factors. Inventories minimise the costs associated with production changes in response to foreseeable (e.g. demand shocks) and unforeseeable (e.g. weather shocks) market trends (CEPS, 2013). The storage of inventories is often considered a market of its own (Pindyck, 2001) and is an integral part of the physical commodity market.

2.2.3. Overview of Futures Markets

Because commodity markets are inherently volatile, physical producers and consumers are seeking means to hedge and strategically trade around risk (Pindyck, 2001). There are many factors which make commodity-based business quite risky, and it is a primary function of the futures markets to facilitate the transference of this risk from more producer with a low tolerance for risk onto investors and (or) speculators with an appetite for risk (Mathews, 2012). Commodity market participants interested in hedging against upcoming price volatility may sell futures contracts today and 'lock in' a particular price-point ahead of the expected production, harvest or when the commodity becomes available, and the transaction will be executed later upon physical delivery according to contract specifications (Pirrong, 1994). The hedging function of futures markets is important, but so is the price discovery function. Futures market trading provides an important role to producers and consumers in the spot market by enabling open market commodity price discovery, which is often used as a price benchmark for a transaction in the spot market (Masters, 2008). Centralised futures markets, therefore, are accepted as the best gauge of demand and supply conditions across spot markets (Ndawona *et al,* 2019). It is the availability of intertemporal price discovery and hedging functions in futures markets which improve trading conditions and decision making today for decentralized spot market producers and consumers, allowing risk to be accounted for and digested accordingly. Futures markets separate the price from the physical delivery of goods, and so these markets allow physical producers to protect themselves (and hedge) against uncertainty associated with potential price risk and volatility. However, the buyers or sellers of futures contracts may opt for liquidation of futures contracts prior to the expected physical delivery period by either choosing to sell or buy the similar contracts of the commodity, thereby counterbalancing the initial commitments (Johnson, 1960).

There is no exchange of cash between the futures market participants when the contract transaction is being processed, and so the futures contract at its establishment is worth zero (Gorton and Rouwenhorst, 2005). Instead, futures contracts are based on the real underlying commodity asset. It is for this reason that the futures market is not exclusively reserved for big commercial producers and companies, or financial institutions.

2.3. Commodity Market Participants

The US regulator, the Commodities Futures Trading Commission (CFTC), has traditionally defined commodity market participants according to two groups of traders, namely, commercial and non-commercial. Those dealing directly with the physical commodity, such as traders, producers and users, would be defined as commercial market participants, whereas those with no direct interest in the physical commodity would be classed as non-commercial participants. Although, as noted by Gorton, Hayashi and Rouwenhorst (2008), it had become more common in the early 2000s for commercial participants to be referred to as hedgers, and non-commercial participants be referred to as investors. The CFTC publishes weekly market reports regarding the holdings, stocks and open interest (uncompleted trades) of commodity market participants in various futures markets across the US, known as the Commitment of Traders (COT) report. However, in 2006, the CFTC itself noted issues with regards to the classifications of traders and trading strategies. The CFTC raised concerns around the fact that commodity trading strategies had evolved to a point where ‘long-side open interest’ in a host of major commodity futures contracts were being held by ‘non-traditional’ hedgers, and questions arose as to the ability of the weekly COT reports to correctly capture and assess futures market activity (Gilbert, 2010). In response to these concerns, in 2009 the CFTC had adjusted the categorisation of commodity traders to be included in what was thereafter referred to as the ‘Disaggregated Commitment of Traders’ reports (Buyuksahin and Robe, 2010). Table 1 below summarises the CFTC’s categories of traders (UNCTAD, 2011).

Table 1: Categories and description of the commodity traders (UNCTAD, 2011)

Category	**Description**
Producers, Processors, End Users, Merchants	Those dealing mainly in physical commodities, and their use of futures markets is for hedging and risk management purposes pertaining to their primary businesses
Swap Dealers	Those dealing mainly in 'Over the Counter' (OTC) swaps, and their use of futures markets is for hedging and risk management purposes pertaining to their business of OTC swaps. Swap dealers are predominantly managing clients' investments which track major commodity indices.
Money Managers	Those managing 'On-Exchange' trading or Exchange Traded Funds in the futures markets for their clients, such as Commodity Trading Advisors or Hedge Funds.
Other Reporting Traders	Reporting traders not mentioned above
Non-Reporting Traders	Those not required to report their positions

The first two categories can be regarded as commercial participants, and the others may be regarded as non-commercial participants. These types of trader categories put forward by the CFTC do clarify some grey areas, but as Tilton, Humphreys and Radetzki (2011) point out, there are still some serious limitations. Some have suggested that it may be more appropriate for the CFTC to classify market participants according to the type of trade executed, as opposed to fixating on the category and identity of the trader, as a market participant can execute trades falling anywhere on a spectrum between that of "pure risk avoidance (hedging) and pure speculation" (Irwin, Sanders and Merrin, 2009). For example, traditional physical hedgers may engage in speculation, and investors may involve themselves in some form of hedging as part of their commodity market strategy (Mathews, 2012).

Sections 2.3.1, 2.3.2 and 2.3.3 introduce the three primary commodity trading strategies. All three trading strategies may very well be employed by the same market participant, and so many are advocating for the CFTC to give preference towards monitoring the types of trades executed, rather than the market participant's identity (Arnuk and Saluzzi, 2008).

2.3.1. Hedgers

A hedging strategy is when futures markets are used as a means of insuring against the possibility of future pricing fluctuations. A traditional hedger is commonly recognized as a physical market participant, as strategic hedging is mostly, with some exception, used by the physical commodity production organisations and users of these commodities seeking to 'lock in' a certain price. The hedging strategy is the best means for commercial participants to achieve more certain outcomes (Hull, 1993). Commodities futures are also used by non-commercial participants, especially swap dealers, to hedge against risk in other asset classes, such as equities, which previously were found to have a negative return correlation with commodities (Gorton and Rouwenhorst, 2005). This type of financial hedging in futures markets is problematic for regulators such as the CFTC, who according to their definitions, would miscategorise these financial hedgers as being commercial participants, and thereby facilitate their circumvention of the types of regulations which are meant to target these non-commercial participants, such as the financial hedger, amongst others (Mathews, 2012).

2.3.2. Speculators

Commercial participants who want hedging protection by selling or buying futures contracts don't normally trade the contracts amongst each directly. Instead, buyers of futures contracts are usually speculators eager to secure positions in particular commodity markets (Hull,1993). This is how speculators are providers of liquidity in commodity futures markets (Friedman, 1953).

Two categories of speculators identified in the futures markets are the 'long-short' and 'long-only' speculators (Tilton, Humphreys and Radetzki, 2011). Long-short speculators are normally highly leveraged traders who at any point are ready to buy or sell contingent on current market conditions and intend to profit through both positive and negative fluctuations in the market (Mathews, 2012). This includes those who operate from trading floors of big financial institutions, and trade using a technical basis (Gilbert, 2010). Long-only speculators on the other hand, are typically unleveraged and are much less sensitive to fluctuations in market prices compared to long-short speculators (Tilton, Humphreys and Radetzki, 2011). Index-related investors are engaging in a form of long-term speculation, and their longer-term horizon investment tracks a 'basket' of commodity futures weighted in the index of their choice. (Tilton, Humphreys and Radetzki, 2011). The long position is maintained because the indices 'roll-over' their investment capital to the closest to maturity futures contracts as the previously held futures contracts approach maturity and expiration. It is in this way that long-only index speculators are never obliged to accept physical delivery of any commodities in the basket.

Long-short and long-only commodity speculation in commodity futures markets has grown significantly since the 2000s (Gilbert, 2010), and both types have received accusations of market manipulation (Mathews, 2012, UNCTAD, 2011).

2.3.3. Arbitrageurs

Arbitrage is how prices of the same commodity on separate exchanges and in different geographies will tend to equalize, because traders take advantage of price differentials (Mathews, 2012). Arbitraging in commodity markets involves purchasing commodities in a particular commodity market, and then selling in an alternative market, or otherwise purchasing commodities in a futures market and then selling in the spot market. The premise of commodity market arbitrage is centered around the notion that prices of the same commodity should be equalise across markets, although prices can differ across markets. An example may be that the price of copper on the London Metal Exchange is cheaper than that on the Chicago Mercantile Exchange, and after considering transactional fees, an arbitrageur may buy copper on the London Exchange and then sell copper on the New York Exchange. The arbitrageurs have unlocked a risk-free profit by raising the demand for copper in London, while increasing the supply of copper in Chicago, and their action therefore leads to prices equalising (Hull, 1993).

2.4. Commodity Price Formation

The primary theory behind commodity price formation is informed by the classical demand and supply model, whereby the price of a commodity will adjust according to changes to its supply and demand. The market for a commodity is said to be in equilibrium when the quantity in demand and the quantity supplied are equal at a certain price. In theory, a profit maximising firm will supply quantities of a commodity until its marginal cost of production equals the marginal revenue, or price, of the final product. Any changes to marginal cost of production or the quantity demanded by the market will initiate supply and demand responses and force the market to re-equilibrate at a new level. Under the assumptions of perfect competition, should increases in the quantity demanded of the commodity cause the market price (marginal revenue) to rise above the marginal cost of production, new entrants may be incentivised to join the market and this may shift the supply curve outwards. This newly unlocked market supply will cause prices to re-equilibrate to the new level at which the market price (marginal revenue) equals marginal cost of production, and industry profits will return to normal levels (Parkin *et al*., 2005).

However, there are multiple complex factors which affect commodity market supply and demand, and therefore commodity prices too. Examples of fundamental factors which drive commodity prices include general economic conditions, exchange rates, monetary policy, costs associated with production, logistical and delivery dynamics, commodity substitutability, consumption patterns, advances in technology, taxation, international and domestic trade agreements, weather events, location specific factors and even political forces (Falkowski, 2011, Horcher, 2005, and Trostle, 2008).

Production of commodities is increasingly by very capital-intensive operations, and it may take considerable time for new production capacity to be unlocked to satisfy growing demand. Although commodity prices are often quite volatile in the shorter term, aggregate supply and demand are more price inelastic (Dwyer *et*., 2011). This, therefore, can result in prolonged supply shortages in response to rapid increases in demand (Meadows, 1969). Demand and consumption patterns tend to be sticky and may change slowly over the longer term. These lagged responses may create demand and supply shocks, which can force larger and more aggressive price reactions (Ndawona *et al*., 2019). Inventories are an important factor influencing the physical supply in a commodity market. Inventories can "cushion" supply and demand shocks. The more widely available inventories are, and those which are easier to store, may have significantly less price volatility compared to those which are hard to store and are likely to demand a premium price (Ndawona *et al*., 2019).

Commodity prices are also influenced by macroeconomic forces such as currency exchange rates, current and anticipated levels of inflation, as well as current and expected interest rate levels. Commodity prices have been found, for example, to have a negative relationship with the US dollar exchange rates (Akram, 2009, ICI, 2012, Krichene, 2008). Because commodities are mostly priced in US dollars, if the US dollar depreciates, international commodity buyers will pay a lower price in their domestic currencies, which may stimulate higher foreign demand. But commodity producer's costs are fixed in their domestic currency and so their profit margin at the current dollar price will fall (Akram, 2009). Essentially, a weak dollar raises the relative purchasing power and demand for commodities by foreign consumers and reduces the relative returns of foreign suppliers and their supplies (Akram, 2009), and so prices should rise.

Commodities such as gold, and to less a degree, silver too, have often been considered an effective hedge against inflation. With respect to inflation expectations, gold has been considered a leader indicator of future Consumer Price Index (CPI) based inflation, and that while other commodities may also perform ahead of future inflation, they lag gold (Ranson, 2014, Narayan *et al.,* 2017). This is why throughout a period of inflation, and if there is an expectation of future inflation, commodity prices and overall demand for can increase (ICI, 2012).

In response to a higher interest rate environment, or expectation that interest rates may increase in the future, the demand for storable commodities may fall due to high cost of storage and anticipation that costs of storage may continue to rise (Campbell, 2006). The anticipation of higher interest rates may incentive new entrants to produce today instead of in the future, which would increase the current supply of commodities and cause prices to fall (Campbell, 2006). Whereas falling interest rates, or the anticipation that interest rates may fall, will raise demand for storable commodities due to carrying costs and storage costs falling, and therefore prices will rise. Commodity prices have a tendency to over react in the short-term based on future expectations for exchange rates and interest rates (Akram, 2009).

2.5. The Relationship between Futures and Spot Prices

The exact interaction between futures and spot prices is still a hotly contested area of research, although it is mostly agreed that futures market prices do have quite a foreseeable effect on spot prices. The upcoming spot price for copper is unknown to all, and while the prevailing futures price for copper is somewhat reflective of the expected upcoming spot price, it can never serve as a perfect predictor (Gorton and Rouwenhorst, 2005).

Fluctuations in the futures and spot prices exhibit high correlations, and these correlations have been found to increase in times of market volatility (Gorton and Rouwenhorst, 2005).

Whether futures prices drive spot price or whether spot drives futures prices is a widely contested, and unresolved area of research. Futures prices are considered to lead, or at least have some firm relation to spot prices, considering the theory and literature on the price discovery function (Staritz, 2012). However, some have suggested there is no relationship or interaction between the spot and futures market whatsoever (Alquist *et al*., 2012, Fattouh *et al*., 2012). It is therefore important to clarify the theoretical linkages between the spot and futures market. Two major theories on the interaction between futures and spot prices exist. The first is 'The Theory of Storage', arguably the most dominant theoretical explanation relating the futures prices to the spot price of a commodity, which includes the 'cost to carry' and the expected profit, or risk premium (Fama and French, 1987). The rival theory is known as 'The Theory of Normal Backwardation', which disputes the notion that futures contract prices indicate the upcoming spot prices, instead, this theory suggests that risk premium flows to those buying the futures (Chang, 1985). Before discussing these two theories in more detail, the theories of contango, backwardation and arbitrage should be covered.

2.5.1. Contango and Backwardation

The futures and spot market prices are unequivocally connected in two scenarios, both of which are discussed at length theoretically and empirically. The first is when a commodities futures contract price at the time of purchase is higher than the prevailing spot price, and so the futures price drops to reach the upcoming spot price, this is called contango (Ndawona *et al,* 2019). The second situation is when the futures price of a commodity at the time of purchase is less than the prevailing spot price, and the futures price then rises to meet the eventual spot price, known as backwardation (Mathews, 2012). As the physical date of delivery for the futures contract nears, both spot and futures price become closer through a process known as convergence (Harper, 2007). When a market is in contango, prospective investors choose to purchase physical commodities as assets within spot markets and then sell them within futures markets (Mathews, 2012). In some economic conditions, commodity traders may choose to short a commodity's futures contracts and then purchase the commodity in physical, arrange transportation, and enjoy a financial gain

(Mathews, 2012). A backwardated market is when commodity market participants may choose to go short the physical commodity and purchase futures contract instead (Harper, 2007). In both cases, the eventual outcome, at least in theory, is that futures prices and spot prices converge.

2.5.2. Arbitrage

Arbitraging is a way that spot market and futures market prices eventually meet. When a commodity's futures contract price diverges from its prevailing spot market price and added transaction costs, such as cost of storage, interest, an arbitrageur may choose to puchase on one side and sell on the other, thereby profiting and encouraging spot and futures prices to come together through a convergence process (Domanski and Heath, 2007).

2.5.3. The Theory of Storage

The most accepted theory connecting futures market prices of a commodity, and its spot market prices is the Theory of Storage (Carpantier and Dufays, 2012, Fama and French, 1988, Fama and French, 2016, Nielson and Schwartz, 2004). This theory, also known as the 'cost of carry' approach, explains the relationship between the futures prices and spot prices according to costs and benefits associated with holding the asset in its physical form (Lauiter, 2006). The futures price [F at time 0] may be understood as a function of the current spot price [S at time 0], plus the cost of carrying the physical commodity [C] (Peirson, 2008).

This relationship may be depicted in the following way;

$$F_0 = S_0 + C$$

Where [C] is the cost of storing the physical commodity plus any interest costs.

2.5.4. The Theory of Normal Backwardation

The Theory of Normal Backwardation, originally coined by Keynes and Hicks, highlights the two major roles of commodity futures markets, the hedging function and providing a publicised futures values, are fundamentally conflicting (Mathews, 2012). Keynes and Hicks refuted the notion that futures prices are an accurate mirroring of the upcoming spot market prices, because the current known futures price, although perhaps higher than the current spot market price, ought to drop below the upcoming spot market prices by the amount of normal backwardation (Kolb, 1992). Indeed, Keynes thought that it is ‘normal’ for the futures market prices to be somewhat of a downward biased gauge for the upcoming spot market prices.

Keynes’s Theory of Normal Backwardation identifies the commodity futures markets as a vehicle for risk transference, so that speculators with less appetite for risk and market participants purchasing options and take long positions may accrue premiums, as they have absorbed risk from the physical commodity market participants, such as those engaged in production or hedging (Mathews, 2012).

The interaction between today’s spot price and the future price may be depicted as follows:

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

The formula shows that 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 based on the future spot price at time t, $E_t(S_T)$, with maturity T and a risk premium as a function of inventory $\pi_{t,T}\ (I)$ (Gorton and Rouwenhorst, 2005, Mathews, 2012). It is in this way that the fundamental basis of futures markets and futures pricing is the anticipated difference in spot prices, and the associated risk premiums (Gorton and Rouwenhorst, 2005).

Keynes and Hicks suggested that long (or short) speculators may accrue risk premiums only by purchasing from short (or long) physical hedgers or producers for a determined price below (or above) the anticipated futures price (Mathews, 2012). Chang (1985) noted that Keynes’s Theory is contingent on the following assumptions; speculators are risk averse, and they hold net long positions, and they are unable to accurately predict and forecast future prices (Mathews, 2012). It is in this way that Keynes suggested the risk premiums would mostly flow to those holding net long positions (Gorton and Rouwenhorst, 2005). Keynes and Hicks argued that risk premium was a manifestation of the supply and demand for long (and short) positions in commodity futures markets (Gorton, Hayashi and Rouwenhorst, 2008). When the positioning and demand from those engaged in short hedging is greater than the supply of net long speculators, there may be a positive risk premium present (Mathews, 2012).

Although the Theory of Normal Backwardation has little academic consensus in the literature, Gorton, Hayashi and Rouwenhorst (2008) found market risk premiums had a direct relation to available inventory as the Theory of Storage suggests. Bryant, Bessler and Haigh (2006) argue that it is impossible to prove or reject the Theory of Normal Backwardation; one, it will never be possible to observe the projected spot prices or any risk premiums, not until the projected (future) spot actually becomes the current spot, and two, it is impractical for those engaged in research to try answer this research question, as manipulation of commodity futures markets in any form is illegal.

2.5.5. Efficient Market Hypothesis

Prior to the 2000-2011 commodity super cycle, the dominant view and understanding of how markets in general worked was based off the Efficient Market Hypothesis (EMH) (Cohen, 2012). This hypothesis posits that in an efficient market, the current price is fully reflective of all available market information and that informational flows are assumed to be frictionless (Fama, 1970). The EMH is built on the assumptions that all market participators always act rationally and make decisions based on fundamental factors (supply and demand) alone, and these decisions are based on all public and private information at the time, with no collusion or excessive returns being possible as they will be ‘arbitraged away’ (Otto, 2011, UNCTAD, 2011).

For commodity markets, the EMH suggests that all past and present information is at any point fully incorporated into the prevailing futures price, and so there is no conceivable way to impact the future spot market prices. If commodity markets are truly operating efficiently, the spot and futures market price is, at least theoretically, reacting to any new information in a simultaneous fashion, and therefore no lead-lag relationship should exist between the two markets (Judge and Reancharoen, 2014). Although, as Grossman and Stiglitz (1980) point out, should access to information be costly or exclusive, it is not possible for market prices to accurately and perfectly reflect all information.

There are two hypotheses built on the premises of the EMH; the unbiased hypothesis and the speculative efficiency hypothesis. In essence both hypotheses suggest that under an efficient market, futures market prices are the top unbiased measure for upcoming spot market prices, and therefore speculative returns are zero (Otto, 2011). Under these assumptions, speculators are viewed by regulators as being unable to influence markets prices (UNCTAD, 2011).

A growing body of research questions the rationale of the EMH when it comes to commodity markets. UNCTAD (2011) suggests that in commodity markets there are growing amounts of market participators holding larger positions, and given the fundamental nature of physical commodity markets, these positions are likely to not be perfectly elastic. It is therefore plausible that larger orders and position resizing can induce shorter term liquidity restrictions and create large price movements (UNCTAD, 2011).

The growing presence of speculative index and algorithmic trading, and herd behavior in commodity markets, may amplify the effect of market volatility and bubble formation (UNCTAD, 2011). Otto (2011) empirically assessed the speculative efficiency hypothesis of the London Metal Exchange's industrial metal market, finding that except for aluminium, other metal market were not operating efficiently. Farchy (2011) noted that in 2010, 617 occasions were identified where a single corporation held a domineering position across the London Metal Exchange's industrial metal markets. In 2022, London Metal Exchange executives were forced to halt nickel trading and canceled 9000 trades which occurred on March 8th, worth more than $4 billion. The move was prompted by a short squeeze which caused nickel futures to rise 250% from approximately $29,000 to $100,000 per ton in a single day's trading.

2.5.6. Empirical Evidence on the Relationship between Futures and Spot Prices

There are many studies in the literature which have investigated the relationship between the futures and spot price, and to what extent futures lead spot, or vice versa, but they are inconclusive. Some studies have found that futures market prices drive spot market prices and facilitate the price discovery function (Aslan *et al*, 2018, Brooks *et al*, 2001, Frino *et al*, 2000, Hernandez and Torrero, 2010, Kang and Lee, 2006, Kawaller *et al*, 1987, Stoll and Whaley, 1990, Talbi *et al*, 2020), whereas there have been some studies which reached the conclusion that spot market prices drive futures market prices through the spot markets dominant role in the price discovery process (Boney *et al,* 2018, Pradhan *et al*, 2020, Ahmed and Sehgal, 2015*,* Srinivasan, 2012, Zakaria and Shamsuddin, 2012). Some papers have found a bidirectional relationship between the futures and spot markets (Gee and Karim, 2005, Jackline and Deo, 2011, Mathews, 2012, Ndawona *et al,* 2019). Others find an ambiguous relationship between the spot and futures prices (Pindyck, 2001, Turnovsky, 1983, Wang *et al*, 2017), and interestingly, some authors have argued there is no relationship between futures and spot markets at all (Alquist *et al*, 2012, Amman, 2012, Fattouh *et al*, 2012).

2.6. Commodity Market Trading

Commodity futures trading may be simply divided between trading on regulated exchanges and Over the Counter (OTC) derivative trading (Etula, 2010). A derivative is a contractual agreement between parties that specifies important conditions. Derivatives are an important instrument in commodity markets, because market participants are able to hedge risk or they may be used for simple speculation (Shanmugam and Armah, 2017). Derivatives do not necessarily involve the physical transfer of commodity assets, and so the buyer may not necessarily ever take on physical ownership of the asset (Tijoe, 2007). Hedgers, speculators and arbitrageurs use commodity derivative instruments for different purposes (Shanmugam and Armah, 2017). The two important economic functions of commodity derivative markets are risk transfer and price discovery. Exchange traded derivatives are standardised in terms of the underlying assets and the contract sizing and expiration dates, whereas OTC derivatives are customisable and often tailored to adhere to the specific requirements of the parties involved.

2.6.1. On-Exchange Trading

Exchanges such as the Chicago Mercantile Exchange (CME) and the International Continental Exchange (ICE) facilitate trading of pre-defined and standardised derivative contracts. Exchanges provide a highly liquid and transparent trading ecosystem with minimal to zero counterparty risk (Mathews, 2012). The exchanges cancel out any potential counterparty risk by ensuring all trades are cleared and all outstanding business must be settled by the end of each business day (UNCTAD, 2011). This is how exchanges insure against any counterparty risk in all trades by acting as the counterparty themselves (Basu and Gavin, 2011). The exchanges are obligated to facilitate a clearing house (or middleman) and serve as the counterpart in any exchange traded deals, which offers an additional layer of insurance and investment security on every trade (Etula, 2010). Exchanges can make a profit from services rendered and charge transactional fees by acting as the supervisor and insurer of all trades.

2.6.2. Off-Exchange 'OTC' Trading

Commodity derivatives trades do not necessarily need to be facilitated by exchanges, and instead, they may be facilitated directly between market parties with more flexible and personalised contract terms to suit the needs of clients (Irwin and Sanders, 2011, UNCTAD, 2011). OTC commodity derivative trading rapidly gained traction throughout the 1990s and early 2000s because organisations could hedge and position themselves precisely according to their risk appetite, without the obligation to report margins each day to the exchange and a regulator. OTCs also gave traders access to commodities which were not exchange traded (Moore and Khoja, 2008).

Precise data is not always available for the OTC market trading activity, but Sanders, Irwin and Merrin (2010) found, at that point in time, approximately 85% of commodity index investment positioning was held by OTC 'swap dealers', or 'market makers' (Irwin and Sanders, 2011, Moore and Khoja, 2008). Swap dealers are mostly regarded as commercial traders, which grants them exemption from being regulated in terms of limits to speculative positioning, unlike physical commodity traders, who are hedging a physical market position, swap dealers are often hedging a financial position (UNCTAD, 2009). A gap in the CFTC's regulation, known as the 'Swap Dealer Loophole' allowed for the exponential growth of financial investor interest in commodity futures derivative markets, leading to the growth in the size of positions in commodity futures contracts held by swap dealers (UNCTAD, 2009). The rapid increase in OTC derivative trading leading up to the 2008 Global Financial Crisis, not just in commodity futures, but sub-prime mortgages too, were identified as being at the center of the 07/08 Global Financial Crisis (Basu and Gavin, 2011). Subsequently, the 2010 Dodd-Frank Wall Street Reform and Consumer Protection Act included regulatory measures to limit OTC derivative trading, and to make OTC trades more transparent (Mathews, 2012).

2.7. Legislative Developments in Commodity Markets

Following the most severe economic depression in 1929 and motivated by certain financial abuse contributing to the Great Depression, key laws were passed in the US to regulate the banking and financial sectors, as well as limit risk taking and speculating by requiring full disclosure of financial information. Arguably the most important regulatory development was the Banking Act of 1933, or Glass-Steagall Act, came as a response to the crashing of the stock market in 1929 and failures US commercial banking ecosystems during the Great Depression (Shanmugam and Armah, 2017). The Glass-Steagall Act set up 'firewalls' between commercial and investment banking operations (Brooks, 2012) to curb excessive speculation. Trading in commodity futures was also more strictly regulated, and the rollout of the Commodity and Exchange Act (CEA) of 1936 permitted stricter U.S. federal regulation of all commodity futures trading operations and made it necessary for all commodity futures and options trading to be performed through regulated and organised exchanges (Shanmugam and Armah, 2017). The purpose of the CEA was to curb excessive speculation which was said to have caused unreasonable and unpredictable fluctuations in commodity prices. These regulations had induced low levels of speculative trading in commodity derivatives which lasted until the early 1970s.

In response to the economic recession of the 1970s, debates around the effectiveness of early post-depression policies were re-opened (Barsky and Kilian, 2000). There is a long history of financial market deregulation in the US following the stagnant economy during the 1970s. This is also the period when trading in agricultural commodity derivatives was liberalised (Shanmugam and Armah, 2017). New exchanges for futures and options trading were introduced in Europe in 1982, such as the London International Financial Futures Exchange (LIFFE). Importantly, these new financial instruments and rapid advancements in information technology throughout the 1980s allowed market participants to trade agricultural derivatives not only via highly regulated public exchanges, but also directly between market participants 'over the counter' (OTC) (Schinasi, 2000). Deregulatory policies continued and expanded throughout the 1990s and 2000s (Shanmugam and Armah, 2017). Two influential and far-reaching financial deregulation laws were passed and implemented in 1999 and 2000, creating an economic environment perfectly conducive for monumental capital flows into the commodity derivative markets.

In 1999, the passing of the Gramm-Leach-Bliley (GLB) Act, referred to as the Financial Services Modernisation Act, revoked part of the Glass-Steagall Act of 1933, and through the removal of certain barriers in the financial markets between commercialised banking, investment banking, securities and insurance companies which had prohibited any of these institutions to consolidate and act as a blend of operations such as investment banking, commercial banking, and or an insurance company (Shanmugam and Armah, 2017). The GLB Act meant that commercial banks, investment banks, securities firms and insurance may consolidate and operate in any combination of the four types of financial services. For some, the passing of the GLB Act was a natural step in the ever-evolving national banking system (Barth *et al*, 2000). The indirect revoking of the Glass-Steagall Act meant that major banks could engage in both commercial and speculative trading strategies and activities with their depositors' money (Heakal, 2003). Amongst other things, this contributed to major increase in overall financial speculators in derivative markets, permitting entirely financial traders and speculating participants to play a greater role in commodity markets (Shanmugam and Armah, 2017).

Because of the growing interest in commodity derivatives after the GLB Act was rolled out, many financial experts and regulators were calling on the US Congress to enforce stronger financial regulations on derivatives trading (Shanmugam and Armah, 2017). One of the most outspoken and important of these people was Brooksley Born who, from 1996 to 1999, was the chairperson of the CFTC. Born persuaded the US Congress and President to provide the CFTC more regulatory supervision of OTC derivatives or "off-exchange" derivative markets, over and above the CFTC prevailing role and oversight of exchange-traded derivatives (Goodman, 2008). Born's concerns were strongly opposed by other regulators, and upon Born's resignation in 1999, the US Congress approved legislation known as the Commodity Futures Modernisation Act in 2000 prohibiting the CFTC from regulating OTC commodity derivatives (Shanmugam and Armah, 2017). The Commodity Futures Modernisation Act allowed for trading of energy derivatives, OTC swaps and other commodity derivatives to be exempt from the CFTC's oversight. Since this regulatory development, OTC derivatives markets grew exponentially, resulting in an even larger tidal wave of investment funds into commodity derivatives (UNCTAD, 2011).

2.8. Commodity Market Financialisation

Throughout the 1970s and 1980s commodity markets saw significant growth of financial futures, and under a changed political climate, the CFTC allocated its resources towards the regulation of traditional financial futures and derivative markets, instead of the commodity futures market (Masters and White, 2008). Importantly, regulating bodies failed to acknowledge the critical fundamental distinctions between a financial (equity) and a commodity market, thereby mistakenly treating both as financial markets, while missing that commodity markets are tied to properties such as physical production, storage and industry price discovery (Master and White, 2008). Due to the growth of open interest and total traded volumes in commodity futures markets, it meant any speculator needed greater position sizes to be able to influence the markets (Mathews, 2012). According to UNCTAD (2009), the initial financial investors involved in commodities were primarily hedge funds who made shorter term investment decisions informed by technical analysis. However, when large exchanges throughout the 1980s and early 1990s shifted from traditional 'open cry' trading floors to electronic trading it become substantially easier for new, and inexperienced market participants to now become involved in commodity trading.

Following key legislative developments in financial and commodity markets, and succeeding the dotcom crash of 2000, investors began looking beyond traditional financial investment options and leaned into commodity futures as a means of achieving portfolio diversification. Indeed, the CFTC reported that overall values of financial investments into popular commodity indices grew from approximately 15 billion dollars in 2003 to more than 200 billion dollars by the middle of 2008 (Tang and Xiong, 2012), whereas overall values of OTC traded commodity derivatives grew 20 times, totaling 13 trillion dollars by the time of the 2008 credit crunch (UNCTAD, 2009). As De Schutter (2010) points out, real commodity prices had largely been stable up until 2004, but from that point onwards the prices of unrelated commodities began to exhibit uncharacteristically synchronised co-movement, and commodity values climbed rapidly, especially after the sub-prime crash in August of 2007. While in real dollar terms, the world's GDP doubled in the period 1998 to 2008, while in the same period commodity values nearly grew fourfold (UNCTAD, 2009). Domanski and Heath (2007) note that in 2008, overall values of outstanding commodity futures contracts (approximately 13 trillion dollars), was twice the annual physical global commodity output. In 2005, the value of exchange traded derivative investments for gold, copper and aluminium were roughly 30 times the annual physical production output (Domanski and Heath, 2007). In fact, throughout the 2000 to 2008 period, the market share of traditional commercial market participants was cut in half, meanwhile the market share of purely financial traders had doubled from less than 20% to north of 40% (Buyuksahin *et al*, 2008).

The explosive increase in real commodity prices across all sectors from the early 2000s was an historic event and was described as one of the most powerful commodity booms ever seen (Humphreys, 2009). The commodity boom over that period was widely attributed to fundamental drivers, like growing commodity demand associated with increased resource intensive urbanisation, industrialisation, and changing dietary habits in primary emerging market economies such as China and India (UNCTAD, 2011). However, an ever-growing body of research argued the extent of the price increases seen throughout such a large commodity spectrum was not easily explainable in terms of market fundamentals such as demand and supply. The volatility seen in both spot and futures price levels across the major commodity sectors, as well as the growing correlation, synchronization and cointegration of price fluctuations between various commodities *and* between the cross-market returns of financial and non-financial assets raised serious concerns of the influence certain non-fundamental drivers were having in price formation (CEPS, 2013). Tang and Xiong (2012) showed that the cointegration and growing correlation was particularly pronounced between commodities which were traded as part of the Standard & Poors – Goldman Sachs Commodity Index and the Dow Jones – AIG Commodity Index and suggested that prices of a commodity were being influenced by the aggregated risk appetite for financial assets and the investment behavior of commodity index investors, as opposed to physical commodity market supply and demand fundamentals.

Evidence in the literature would strongly suggest that before 2000, commodity markets were separated from the traditional financial market (Tang and Xiong, 2012). Commodity prices traditionally had a low positive correlation between each other, and commodity market returns had minimal cross-market return correlation with the returns of top equity indices (Erb and Campbell, 2006). However, shortly after the collapse of the equity markets following the dot com boom and bust, a widely publicised discovery by Greener (2000) and Gorton and Rouwenhorst (2005) finding that commodity and equity market returns were negatively correlated had illuminated the potential diversification benefits of investment exposure to commodities. This permitted institutions to begin promoting commodities as a new financial asset class with good inflation, dollar exchange and equity market hedging characteristics (Ndawona *et al*, 2019).

Increased cross-market return correlation over this period is an important manifestation of commodity financialisation and an important line of research within the commodity financialisation debate. This is especially true given that the original basis for considering adding commodity exposure as an alternative value-add investment component in investor portfolios was due to the fact that it was known that a low negative return correlation existed between commodity and equity markets (Kang, Tang and Wang, 2023). If the low and negative return correlation between commodities and equities were true, then, based on portfolio optimization theory, commodity exposure in an investor's portfolio could somewhat reduce the variance of the portfolio, thereby improving the risk-return ratio during periods of volatility in equity markets (Kang, Tang and Wang, 2023). However, as Tang and Xiong (2012) have shown, when commodity investments were popularised in the 2000s, exponential growth of investment inflows and allocation towards the commodity markets thereafter had fundamentally altered the return correlation structure between the commodity and equity markets. Tang and Xiong (2012) found that the inflow of index investment from the early 2000s onwards led to a fundamental structural change and an increase in the return correlation between commodity and equity markets, a phenomenon thereafter known as the financialisation of commodity markets.

These fundamental changes in commodity markets have made the subject of commodity investors and traders a contentious topic. Researchers and regulators had argued the lack of transparency concerning the identity of commodity traders, in combination with a rapid increase in investment, had substantially impacted spot market and day to day commodity prices, thereby increasing the risk which physical market participants undertook when executing real decisions around storing, investing and trades (UNCTAD, 2011). However, many institutions and economists were unwilling to entertain this notion and continued to declare that limited proof exists to prop up claims suggesting financial investments have had any substantial or enduring influence on real world prices beyond what is easily explainable with reference to demand and supply fundamentals (Tilton, Humphreys and Radetzki, 2011).

2.8.1. Commodity Futures Indices

Harry Markowitz, widely thought of as the father of modern portfolio theory, produced a framework for investment decisions in 1952 whereby investors decide on investment portfolio allocations according to expected rates of returns and expected risks across multiple combinations of risky assets (Stoll and Whaley, 2009). These investments were initially in high liquid equity, bonds or currency exchange markets, although in the late 1990s the fees and obstacles of proxy investments like that of commodity derivatives were overcome (Stoll and Whaley, 2009), greatly assisted by major commodity exchanges introducing electronic trading platforms. Financial investors had identified commodity futures as an opportunity for diversification, encouraged by influential papers (Greener, 2000, Gorton and Rouwenhorst, 2005) highlighting that returns from commodities may offer portfolio stability as they were found to be inversely correlated with equities (Tilton, Humphreys and Radetzki, 2011).

Commodity futures are quite distinct compared to traditional derivative investments because upon maturation of a futures contract, specified quantities of the commodity need to be physically delivered. In the case of commodity indices, this obstacle is easily avoided through what is known as the process of “rolling” forward, by choosing to replace the maturing contract with an equivalent nearest to maturity contract, and it is in this way that commodity index investing can offer returns to ‘passive long positions’ (Domanski and Heath, 2007, Tang and Xiong, 2012). Commodity index investment is appealing to institutions like pension or hedge funds, who strategically manage long term investments, as they are a cheap and unleveraged means of diversification, commodity prices historically tended to have low correlation with other assets, high correlation with inflationary trends, and yield returns comparable to equities, and therefore considered a reasonable investment (Domanski and Heath, 2007).

The two benchmark commodity indices are the S&P GSCI and the DJ-UBSCI. Each commodity’s weighting and each commodity sector in the S&P GSCI is tied to the real global production average of the last five years, and for the DJ-UBSCI, it is the total amount of trades in that commodity over the same five years which determine the index’s individual commodity weightings (Gilbert, 2010, Stoll and Whaley, 2009). Commodity index investments don’t usually occur on major commodity exchanges because of the costs involved, and so this is why such investments are usually facilitated by a third-party fund manager or via OTC swap deals (Stoll and Whaley, 2009).

Although the exact level of investment into commodity indices throughout the 2000-2011 super cycle is unclear, the CFTC estimated that investment may have risen from approximately 10 billion dollars in 2002 to more than 211 billion dollars by November 2010 (Tilton, Humphreys and Radetzki, 2011). Commodity index related investments in agricultural commodities such as corn, soybeans, wheat, cattle and hogs grew from approximately 10 billion dollars in 2006 to north of 46 billion dollars in 2007 (De Schutter, 2010). Indeed, the behavior of commodity indices has been shown to have played an important role in overall financial volatility, because in July 2008, when the S&P GSCI was at its peak value, following the fall of Lehman Brothers, the S&P GSCI proceeded to lose approximately 37% of its value, which meant that financial investors with longer term positioning would have suffered financial loss (Basu and Gavin, 2011).

Given the large weighting of the energy sector in both the S&P GSCI and DJ-UBSCI, especially crude oil, it is plausible to assume that oil price fluctuations are a serious driver of other commodity futures prices linked to major indices, regardless of demand and supply drivers (Ghosh, 2011). The US CFTC acknowledged that commodity index investments were associated with the increase of futures prices in the 2006-2008 period, and specifically the doubling of the price of wheat between the months of June and December in 2010 (Ghosh, 2011, Stoll and Whaley, 2009). Despite these controversial findings, emanating from the CFTC itself, authors such as Irwin and Sanders (2010), and Stoll and Whaley (2009), have suggested the correlation of growing investments into commodity futures markets and rising spot market prices during the 2000-2011 super cycle does not necessarily prove causation.

If commodity index fund investments did play a dominant role during the 2000-2011 super cycle it would be most detectable through co-movement and cointegration between futures prices weighted in major indices, a correlation which Gorton and Rouwenhorst (2005) failed to find. However, later studies such as Gilbert (2010), and Tang and Xiong (2012) found growing correlation and co-movement amongst indexed commodity futures prices. Stoll and Whaley (2009) also found these increased correlations but insisted that that may not be linked to commodity index investment. Stoll and Whaley (2010) found futures contracts for soybeans, which is indexed, and oats, which is not weighted in a major index, to display significant co-movement, and therefore argued that co-integration between commodity futures prices may not simply attributable to index investments, but instead to traditional mechanisms such as demand and supply fundamentals. However, it is also plausible to suggest that co-movement between indexed and non-indexed commodity futures, such as soybeans and oats, are not necessarily driven by fundamentals, as commodity futures indices is one example of a vehicle for those with speculative intent in commodity markets, a host of other speculative commodity trading strategies may exist beyond simply tracking the major indices which could drive co-movement in prices (Mathews, 2012).

A possible reason why Gorton and Rouwenhorst (2005) did not find evidence of rising co-movements between indexed commodities may be because the empirical analysis was conducted quite early within the super cycle period. Tang and Xiong (2012) showed that it was only from 2005 onwards that a noticeable increase in co-movement and pairwise return correlation between commodity prices was found, most notably between oil and index weighted commodity futures. Interestingly, Irwin and Masters (2010) came to the conclusion that increased investment in commodity indices led to lower market volatility, a finding which was contested by Tang and Xiong (2012), finding that in 2008, a variety of commodities weighted in major indices experienced much larger overall volatility compared to other non-indexed commodities, a contrast they partly attributed to indexed commodities being highly correlated with crude oil. The findings from Tang and Xiong's (2012) paper suggested commodity price increases could *not* have been solely influenced by market fundamentals, such as growing demand for commodities from emerging regions, instead they were influenced by the behavior of index investors in commodity markets. Indeed, return correlations between indexed commodity futures prices increased simultaneously with the growth in open interest in these commodities (Hong and Yogo, 2010). Tang and Xiong (2012) suggested that those with financial investments exposed to the US dollar considered commodity indices as an appropriate opportunity to hedge, resulting in a negative correlation between the dollar exchange rate and the prices of commodity indices, a finding re-confirmed in a recent paper (Kang, Tang and Wang, 2023).

2.9. Commodity Market Super Cycles

The primary differences between a commodity super cycle and normal commodity price cyclicality is the time frame of the cycle, as well as its overall scale and scope (Mann and Keeton, 2013). Heap (2005) considered a commodity super cycle to be an extended period characterised by upward trending real prices of commodities. Generally, commodity super cycles are driven primarily by demand side drivers, especially when there is excess demand emanating from countries experiencing rapid sustained commodity and resource intensive economic growth associated with large scale urbanisation and industrialisation (Heap, 2005). In addition to demand side drivers such as rapid economic growth, a lagged supply side response, and therefore the inability to catch up and meet the growing demand, will accentuate the upward pressure on commodity values.

Since the Second World War there have been two distinct commodity price booms, and one exceptional commodity price super cycle described by Humphreys (2009:1) as “the most powerful and sustained such boom since the Second World War”.

2.9.1. The 1950-1952 Commodity Price Boom

The first boom began in 1950, directly related to the Korean war, where prices exploded and remained elevated for two years. The Korean war impacted commodity prices directly and indirectly. The direct impact stemmed from the uncertainty around the supply of industrial materials, as the South and East Asia reasons was a key supply region of agricultural and mineral commodities (Radetzki, 2006). The initial uncertainty and concerns triggered hoarding and stock piling of strategic inventories, which artificially pumped-up demand and put upward pressure on prices (Radetzki, 2006). At this point in history no investment vehicles for speculation in commodity markets had been introduced, so while speculative demand did contribute to commodity market strength in the 1950-1953 period, it likely played a lesser role compared to future booms (Shiller, 2000). The indirect impact of the Korean war was that it boosted economic growth and overall industrial output because of war production (Radetzki, 2006). Commodity prices first peaked in 1951, having risen 45% compared to 1949, and by the second quarter of 1952 prices had fallen, and were then only 16% higher compared to 1949 (Radetzki, 2006). Prices recovered in the back end of 1952, only to fall in 1953 and then rise again in 1954 (Radetzki, 2006). Interestingly, the war and the stronger macroeconomy in 1950 and 1951 had a limited impact on energy and food prices (Radetzki, 2006). A possible explanation for the relative weakness of these sectors is that large countries were mostly self-reliant at the time in terms of energy and food (Radetzki, 2006). Comparatively, the effect of the 1950s commodity boom was most evident in the metals and minerals sectors, whereby price levels were 20-30% higher compared to 1949, whereas all other commodity prices were at the same levels in 1952 as 1949, which led many to conclude that this commodity boom was a 'transient phenomenon' (Radetzki, 2006).

2.9.2. The 1973-1975 Commodity Price Boom

The second boom occurred in 1973, and was much stronger compared to the first, as prices of all commodity groups increased substantially for two years and then fell sharply in 1975. Similarly to the 1950s coomodity boom, 1972 and 1973 were characterised by a strong macroeconomy, which served as a catalyst to rising commodity prices (Radetzki, 2006). Although, two 'triggers' of the commodity price boom were identified, firstly, for two years prior to 1973 there were extensive crop losses, resulting in scarce food inventories and uncertainty, and substitutional land use intensified the insufficient supply of agricultural commodities (Radetzki, 2006). Hence the first two commodity groups to experience the pronounced upward price moves were the food and agricultural materials sectors (Radetzki, 2006). The second trigger of this commodity boom was an orchestrated move by the 'oil cartel' OPEC in the second half of 1973 which rocketed oil prices. Considering the large weighting of crude oil in the global commodities markets, this significantly impacted the pricing of all commodities (Radetzki, 2006).

In contrast to the 1950s boom, the 1970s boom was characterised by higher inflation and fundamental changes to major currency markets, which left major currencies 'free floating' after the 'dollar anchor' was removed (Radetzki, 2006). The rapid inflation and major changes, as well as poor stock market performance during this period (Shiller, 2000) had driven many financial investors to shift away from bonds and equities towards hard assets such as property and commodities (Radetzki, 2006). Cooper and Lawrence (1975) suggested that the view of commodities at the time as being a 'safe investment' and a reasonable store of value initiated a flow of speculative demand for commodity inventories and was therefore a contributing factor to the 1970s boom. Although all commodities sectors saw their peak values in 1974, the immense pressure of the recession and the prevailing oil crisis, throughout 1974 the prices in the metals and agricultural materials sectors fell sharply (Radetzki, 2006). While food prices also fell during this time, it was much less steep a decline, attributable to less sensitivity to the business cycle (Cooper and Lawrence, 1975).

2.9.3. The 2000-2011 Commodity Super Cycle

Similar to the two prior booms, the 2000-2011 super cycle was punctuated by a significant demand side catalyst, attributable to rapid macroeconomic growth from developing regions. Producers were not prepared for record demand for oil and copper in 2004, paired with low inventories and minimal additional production capacity, prices were pushed rapidly upwards (Humphreys, 2009). China and India were going experiencing a developmental growth spurt which required intensive primary materials and commodities as opposed to that of more mature economics. During this time, the overall influence and growing economic contribution of greater Asia to global GDP, GDP growth and consumption of prime materials and commodities rose sharply (Radetzki, 2006). China was the key with reference to these metrics. According to Albanese (2006), in select metal markets China's dominance was unrivaled, as its share of international demand growth between the years of 2000 and 2005 was more than 50% for aluminium, 95% for copper and 84% for steel. It was during this time when China became a prominent engine of international economic growth.

Unlike the first two commodity price booms, speculative trading activity in commodity markets had also contributed significantly to the demand for metals, energy and agricultural commodities (Radetzki, 2006). The combination of key legislative developments in commodity and financial markets and poor equity market performance in the early 2000s together with widely publicized findings (eg: Greener, 2000) highlighting commodity investment as a profitable substitute asset class with portfolio diversification benefits, collectively contributed toward the process of commodity market financialisation. By this stage, instruments and investment vehicles had been developed to easily facilitate speculation in commodity futures markets. Institutions fund managers, who were not active in commodity markets in the previous commodity price booms, were now actively involved in commodity markets and speculating in select commodity futures (Masters, 2008). The

S&P GSCI and the DJ-UBSCI soon became popular, and eventually staple investment vehicles for those looking for diversified exposure to commodities.

The contestation around which of the above factors drove the 2000-2011 commodity super cycle may be divided into two camps, those who explain the super cycle in terms of "fundamental" drivers, such as supply and demand dynamics, and those who contest that the super cycle is explainable in terms of "non-fundamental" drivers, such as commodity market financialisation. The latter group argue that the process of financialisation *fundamentally* changed how commodity market's function.

2.9.3.1. Empirical Findings Supporting the 'Fundamentals' Case

Several authors have argued that the 2000-2011 super cycle was driven by fundamentals and contend that any additional regulation of the futures market is unnecessary (Irwin and Sanders, 2011). In some cases, this group praise the benefits associated with commodity market financialisation, such as improved market efficiencies and deepening of overall commodity markets. ICI (2012) suggested that the volatility of commodity prices throughout the 2000-2011 period cannot be attributable to the financialisation phenomenon.

Arguably the most common explanation of the 2000-2011 commodity super cycle is that rapidly growing economies of China and India, produced a large demand shock (Falkowski, 2011). These demand shocks are said to have occurred concurrently with the stabilisation of crude oil production, and the reduced consumer sensitivity to pricing fluctuations, thereby possibly firmly sustaining demand and driving prices to peak levels (Kilian and Murphy, 2014). Heap (2005) notes that increasing costs of producing key commodities during the early 2000s were a notable factor which hindered supply side responses to the growing demand. Additionally, Humphreys (2009) notes that there was substantial disinvestment in mining industries during the dot com boom era of the late 1990s, meaning that the sector was simply unable to respond to future increases in demand.

It should be noted that changes in dietary options in countries like China towards more protein rich alternatives sustained high demand for select agricultural products during the 2000s (UNCTAD, 2011). Grain and softs markets also experienced fundamental shifts, as there were several well-documented weather-related production issues, a shortage of investment in primary agricultural infrastructure, and farms diverting from traditional row crop farming techniques toward bio-fuel based production (UNCTAD, 2011). Such fundamental supply side drivers were said by this group of commentators to have caused continued high grain prices.

Buyuksahin and Harris (2009), and Stoll and Whaley (2010) applied Granger-causality testing to establish whether a relationship existed between growing investment in commodity index funds and the returns of commodity futures in the 2000-2011 super cycle. The two groups of authors concluded that there was little significant statistical evidence found to prove any meaningful relationship existed between index investments and futures returns, and therefore concluded that any alleged speculative investment into commodity futures markets say, through indices, had no impact on commodity futures contract pricing, or on the commodity spot markets.

Irwin and Sanders (2010) conducted a study to determine the possible effect that commodity traders' positions had on prices and overall volatility of 19 exchange-traded commodities by utilising a cross-sectional regression analysis. They concluded that there was little, if any, evidence to support the idea that commodity index investment and trader's positions in such investment vehicles had any influence on the price and volatility of futures contracts.

Dwyer, Holloway and Wright (2012) too utilized Granger-causality testing as a means of determining if financial speculation in commodity futures markets had an impact on spot markets. It was found that excessive financial speculation in futures markets could effect spot markets and induce volatility past what is explainable with reference to fundamental drivers, although they concluded that there was no evidence of this during the 2000-2011 super cycle to support claims of financialisation. Instead, they attributed the significant increase in commodity prices throughout this period to fundamental drivers such as China becoming a prominent global growth engine, causing the demand for most commodities to rise and thereby contributing to rising return correlation amongst commodities. In addition, Dwyer *et al.* (2012) suggested that the prices increased equally as much for commodities that didn't have mature futures markets as for those which had well developed futures markets. As a potential alternative explanation for the rising return correlation amongst commodity prices in the 2000-2011 period, they pointed to the fact that in previous times of increasing return correlation between commodity prices and financial assets, financial investments played little or no role in commodity markets during those periods.

Fattouh (2012) found clear evidence of the increased financialisation of oil futures markets throughout 2003 and 2008, and also found rising co-movements between asset classes, but that these co-movements were also found in off-index markets with no futures exchanges. These findings provide another alternative explanation for the rising return correlations during the 2000-2011 period, one based on common economic fundamentals existing between commodities. Fattouh (2012) ran vector autoregressive models which tested alternative ways of explaining the price dynamics of oil during the commodity boom and found no evidence to suggest that speculation played a key role and concluded that futures and spot prices were driven by common factors which reflected economic fundamentals.

Chari and Christiano (2019) used a large panel data set of commodity prices across multiple sectors, including commodities with futures markets, and commodities with no futures market, to establish if any relationship exists between the financialisation of commodity futures markets and commodity spot market behavior. It was concluded that little to no proof was found to support the claims of a relationship existing between the commodity futures financialisation phenomenon and behavior of spot prices.

Main, Irwin, Sanders and Smith (2018) investigated if the financialisation of commodities futures markets reduced or drove up risk premiums available to long-only commodity investors such as index investors. Their intention was to determine whether the rise of long-only (index) commodity investors influenced risk premiums which such investments were designed to earn. They found little evidence of risk premiums throughout multiple commodity markets fell in a systemic way compatible with the financialisation school of thought. Their results suggested that the average unconditional returns to individual commodity futures is equal to approximately zero both pre- and post-financialisation. Finally, they concluded that the long-only (index) returns in commodity futures markets were informed by idiosyncratic fluctuations in supply and demand fundamentals.

Bohl, Irwin, Putz and Sulewski (2023) conducted a study in response to accusations that the inflows of financial capital from index investors since the early 2000s has had a negative influence on the efficiency of futures markets and thereby keeping at price levels impossible to justify with reference to fundamentals. They tried to quantify market efficiencies, and empirically investigated alleged effects that commodity index traders on 34 commodity futures throughout the 1999-2019 period. They concluded that empirical evidence suggested that commodity futures financialisation in fact has positively affected the degrees of market efficiency for indexed commodity futures markets. Interestingly, they claim that in the presence of commodity index trader activity, there are elevated levels of informational efficiency in indexed futures markets.

2.9.3.2. Empirical Findings Supporting the 'Non-Fundamentals' Case

An increasing framework of empirical research has found evidence supporting the Masters' Hypothesis, or commodity financialisation school of thought, in explaining the 2000-2011 commodity super cycle. Essentially this camp believes that although there may have been noteworthy fundamental and macroeconomic drivers at play both before, and during the 2000-2011 period, these are beside the point, as the velocity and extent of the super cycle are attributable to non-fundamental drivers.

Tang and Xiong's (2012) seminal study investigated the hypothesis that if commodity index financialisation played an important part in the 2000-2011 super cycle, and was responsible for elevated volatility, then it was expected that the prices for various unrelated indexed commodities would be found to be increasingly more correlated due to index compositions and methodology, as compared to the pre-financialisation period. They confirmed this hypothesis and found that the financialisation process made a substantial impact on pairwise return correlations both within and between indexed and non-indexed commodity futures contracts. Importantly, Tang and Xiong (2012) found that the massive inflow of index investors into commodity markets from the early 2000s was also responsible for a fundamental change in the cross-market return correlation structure of commodity and equity markets – a phenomenon they attributed to the financialisation of commodity markets. They concluded that their findings suggest that because of commodity financialisation, prices of an individual commodity was not exclusively informed by supply and demand fundamentals, and instead were determined by a spectrum of financial factors including the aggregate risk tolerance for financial assets, and the trading behavior of commodity index investors.

Bicchetti and Maystre (2012) studied day to day co-movement of the returns of commodity and equity markets in the US throughout 1997-2011. Their empirical findings supported the notion that financialisation had a noteworthy impact on commodity price determination. They concluded that price movements in commodity markets before 2012 were hardly reflective of changes in supply and demand. In line with these findings, Masters (2008), De Schutter (2010) and Mayer (2012) also concluded that after commodity futures index trading and investing was popularised, and the subsequent growth of institutional capital flowed into these markets, prices and volatility have been adversely impacted.

Gilbert (2010) found a statistically significant relationship between the growth of commodity futures index trading volumes and the returns of several key commodities like crude oil, copper and aluminium futures. These were found to have become increasingly more correlated with each other throughout the 2000-2011 period.

Basak and Pavlova (2015) modelled the financialisation of commodity markets in a way which separates the institutional investment flows and traditional or fundamental demand and supply dynamics. They achieved this by constructing a model for commodity futures markets whereby futures prices fluctuated as a response to three 'shocks'. The first is commodity demand related shocks, the second is commodity supply related shocks, and the third is endogenous price fluctuations associated with investment assets under institutional management, i.e. financialisation effects. Basak and Pavlova (2015) found that when institutional investment flows are present, the futures prices of all indexed commodities rise substantially more than non-indexed commodities. In line with Tang and Xiong's (2012) conclusions, Basak and Pavlova (2015) found a rise in correlation *both* between commodities (i.e. pairwise return correlation) and between equities and commodities (i.e. cross-asset and cross-market return correlation), although the (return) correlations for index commodity futures rose by a significantly greater amount. These findings provide further evidence which suggests that prices during the 2000-2011 super cycle were driven by non-fundamentals, such as the financialisation phenomenon.

Kang, Tang and Wang (2023) re-examined if the findings of Tang and Xiong (2012) held true since the seminal paper was released in 2012. Their new analysis finds that the financialisation process has continued to drive a substantial increase in cross-market return correlation between equity and commodity market returns. Similar to the original findings of the seminal paper, a structural change in the cross-market return correlation is evident, and the results were robust even when different commodity and equity market return methods are used. They found that these increases in cross-asset market return correlations were persistent throughout the post-financialisation period. In line with the findings of the original research paper, there is a persistent rise in pairwise return correlation within the commodity futures markets after financialisation, although the increase in return correlation relative to the pre-financialisation is comparatively modest in the more recent years. In addition, they found a significant proportional increase of non-commercial commodity participants operating within commodity futures markets, and the proportion of traditional (non-reportable) commodity participants fell in the post-financialisation period. What this finding meant that after financialisation, non-commercial speculators such as institutional investors, become substantially more proportionally significant actors in commodity futures markets, whereas smaller, non-reporting investors, have been phased out of the market (Kang, Tang and Wang, 2023). Their study shows that financialisation of commodity markets has fundamentally and persistently altered critical features of commodity futures markets, and that further research efforts are needed to achieve a better understanding of the lasting impact such changes have had.

2.10. Conclusion

Chapter 2 provides an overview of how commodity markets work and what is meant by the financialisation of commodity markets. One conclusion which may be drawn from the existing literature is that it is very difficult to quantify the impact that commodity financialisation has had on commodity markets. The difficulty in quantifying the impact stems from the fact that the early stages of commodity market financialisation coincided with rapidly increasing commodity demands of fast growing Asian economies. Therefore, the literature is very polarised when it comes to explanations for the 2000-2011 commodity super cycle. Empirical findings on commodity market financialisation tend to be divided between those emphasizing fundamentals such as demand and supply drivers, or those highlighting non-fundamentals, such as the financialisation of commodity market investing.

While commodity prices during the 2000-2011 were influenced by both fundamental and non-fundamental drivers, empirical work from both camps were able to find evidence to support their claims. As highlighted by UNCTAD (2011:24) “those that attribute most of the development of commodity prices to fundamental factors and those that point to an additional impact from increased financial investment have thus been able to provide empirical support from their point of view”.

An area within this realm of research which remains highly contested, is whether rising futures prices during the 2000-2011 super cycle period also drove up spot prices. It has proved very challenging to determine the answer to this question empirically and so there is minimal available research on the relationship between futures and spot prices, let alone studies addressing this question within the context of the 2000-2011 super cycle.

CHAPTER 3:
DATA, DATA SOURCES AND RESEARCH METHODOLOGY

3.1. Introduction

The data, data sources and research methodology utilised in this paper are discussed in this chapter. The author's primary method of research is quantitative analysis, and the research paradigm is positivist.

Chapter 3 is structured in the following way: Section 3.2 is a description of the data and the data sources. Section 3.3 explains Method 1, the rolling return correlation method. Section 3.4 describes the methods for testing the stationarity and order of integration of the time series data used in Method 2. Section 3.5 explains Method 2, the multiple regression analysis. Section 3.6 is the conclusion.

3.2. Description of Data and Data Sources

The primary data source for this study is the Thompson Reuters (Eikon) 'DataStream' online database, which was accessed on the 18th of April 2024 through the Rhodes University Library.

Included in this analysis are futures prices of commodities included in the most popular global commodity indices such as the S&P-GSCI, DJ-UBSCI and the Bloomberg Commodity Index (BCOM). Table 1 illustrates the composition of the three major commodity indices, and the weightings for individual commodities and commodity sectors as per the official 2023/2024 index methodology publications for each index.

Table 2: Commodity futures traded in the United States and weights in the S&P GSCI, DJ-UBSCI and BCOM indices. All data and weights are drawn from the respective 2023/2024 index methodology publications.

Commodity	S&P GSCI	DJ-UBSCI	BCOM	Exchange	Unit
Energy	***58.430%***	***33.331%***	***30.13%***		
WTI Crude Oil	19.308%	10.93%	7.3620%	NYMEX	bbl
Brent Crude Oil	20.728%	9.471%	7.6379%	ICE - EU	bbl
Heating Oil ULSD	4.8122%	2.181%	2.1604%	NYMEX	gal
RBOB Gasoline	4.3854%	2.199%	2.2073%	NYMEX	gal
Natural Gas	3.4659%	5.737%	7.9841%	NYMEX	mmbtu
Gas Oil Low Sulfur	5.7293%	2.813%	2.7798%	ICE - EU	mt
Grains	***14.590%***	***23.996%***	***23.10%***		
Corn	6.0007%	5.927%	5.6623%	CBOT	bu
Soybean	3.9660%	8.974%	5.9068%	CBOT	bu
Chicago Wheat	3.1746%	2.595%	2.8184%	CBOT	bu
Kansas Wheat	1.4490%	1.109%	1.8189%	KBOT	bu
Soybean Oil	0	2.484%	3.3491%	CBOT	lbs
Soybean Meal	0	2.907%	3.5401%	CBOT	st
Rough Rice	0	0	0	CME	cwt
Oats	0	0	0	CME	bu
Softs	***4.093%***	***5.351%***	***7.35%***		
Coffee	0.8540%	1.816%	2.9741%	ICE - US	lbs
Cotton	1.0153%	0.953%	1.5703%	ICE - US	lbs
Sugar	1.8882%	1.768%	2.8076%	ICE - US	lbs
Cocoa	0.3349%	0.814%	0	ICE - US	mt
Lumber	0	0	0	CME	brd ft
Orange Juice	0	0	0	ICE - US	lbs
Livestock	***7.730%***	***3.988%***	***5.25%***		
Feeder Cattle	1.6238%	0.754%	0	CME	lbs
Live Cattle	4.0013%	2.143%	3.4650%	CME	lbs
Lean Hogs	2.1048%	1.091%	1.7828%	CME	lbs
Pork Bellies	0	0	0	CME	lbs
Industrial Metals	***10.482%***	***17.548%***	***15.35%***		
Aluminum	3.4992%	3.640%	4.1056%	LME	mt
Copper LME	4.4866%	6.955%	0	LME	mt
Copper CMX	0	2.384%	5.2978%	C0MEX	lbs
Nickel	1.1297%	1.989%	2.5842%	LME	mt
Lead	0.5395%	0.667%	0.8661%	LME	mt
Zinc	0.8273%	1.913%	2.4945%	LME	mt
Tin	0	0	0	LME	mt
Precious Metals	***4.675%***	***15.784%***	***18.82%***		
Gold	4.2516%	12.99%	14.3468%	COMEX	oz
Silver	0.4223%	2.516%	4.4770%	COMEX	oz
Platinum	0	0.278%	0	NYMEX	oz
Palladium	0	0	0	NYMEX	oz

Table 3: Commodity futures data used in the analysis.

Commodity	Original Data Description	Source (Thompson Reuters Eikon DataStream)
Energy		
WTI Crude Oil Futures	NYM Light Crude Oil TRC1 SETT. PRICE	New York Mercantile Exchange
Brent Crude Oil Futures	ICE Brent Crude Oil TRC1 SETT. PRICE	Intercontinental Exchange (EU)
Heating Oil ULSD Futures	NYM NY Harbour ULSD TRC1 SETT. PRICE	New York Mercantile Exchange
Natural Gas Futures	NYM Natural Gas TRC1 SETT. PRICE	New York Mercantile Exchange
Gas Oil Futures	ICE Gas Oil TRC1 SETT. PRICE	Intercontinental Exchange (EU)
Grains		
Corn Futures	CBOT Corn COMP TRC1 SETT. PRICE	Chicago Board of Trade
Soybean Futures	CBOT Soybeans COMP TRC1 SETT. PRICE	Chicago Board of Trade
Chicago Wheat Futures	CBOT Wheat COMP TRC1 SETT. PRICE	Chicago Board of Trade
Kansas Wheat Futures	KBOT HRW Wheat COMP TRC1 SETT. PRICE	Kansas Board of Trade
Soybean Oil Futures	CBOT Soyabean Oil COMP TRC1 SETT. PRICE	Chicago Board of Trade
Soybean Meal Futures	CBOT Soyabean Meal COMP TRC1 SETT. PRICE	Chicago Board of Trade
Oat Futures	CBOT Oats COMP TRC1 SETT. PRICE	Chicago Board of Trade
Softs		
Coffee Futures	CSCE Coffee ‘C’ TRC1 SETT. PRICE	Intercontinental Exchange (US)
Cotton Futures	-	Intercontinental Exchange (US)
Sugar Futures	CSCE Sugar #11 TRC1 SETT. PRICE	Intercontinental Exchange (US)
Cocoa Futures	-	Intercontinental Exchange (US)
Livestock		
Feeder Cattle	CME Feeder Cattle COMP TRC1 SETT. PRICE	Chicago Mercantile Exchange
Live Cattle	CME Live Cattle COMP TRC1 SETT. PRICE	Chicago Mercantile Exchange
Lean Hogs	CME Lean Hogs COMP TRC1 SETT. PRICE	Chicago Mercantile Exchange
Industrial Metals		
Copper (LME) Futures	LME Grade A Copper TRC1 SETT. PRICE	London Metal Exchange
Copper (COMEX) Futures	CMX High Grade Copper TRC1 SETT. PRICE	Chicago Mercantile Exchange
Aluminium Futures	LME Aluminium TRC1 SETT. PRICE	London Metal Exchange
Nickel Futures	LME Nickel TRC1 SETT. PRICE	London Metal Exchange
Zinc Futures	LME Zinc TRC1 SETT. PRICE	London Metal Exchange
Lead Futures	LME Lead TRC1 SETT. PRICE	London Metal Exchange
Tin Futures	LME TIN TRC1 SETT. PRICE	London Metal Exchange
Precious Metals		
Gold Futures	CMX Gold 100 oz TRC1 SETT. PRICE	Chicago Mercantile Exchange
Silver Futures	CMX Silver 5000 oz TRC1 SETT. PRICE	Chicago Mercantile Exchange
Platinum Futures	NYM Platinum TRC1 SETT. PRICE	New York Mercantile Exchange
Palladium Futures	NYM Palladium TRC1 SETT PRICE	New York Mercantile Exchange

The commodity futures data used in the analysis are continuous series of daily settlement prices (USD). As seen in Table 2, all commodity futures data are continuous daily settlement price series classified by ‘TRC1’. TRC is the code for the Thompson Reuters Eikon DataStream’s proprietary continuous price series for individual futures prices. Because individual commodity futures contracts expire upon maturity, it is necessary to utilize continuous price series such as TRC1 in this analysis. TRC1 is a first position continuous series of the nearest futures contract’s daily settlement prices which is then rolled to the closest nearby contract’s prices on the last trading day of the previous contract (Princeton, 2025). Thompson Reuters Eikon DataStream uses TRC# to represent its own internally generated continuous daily price series. TRC1 considers the first nearby contract, whereas, for example, TRC2 considers the second nearest contract, and so forth (Visa, 2019). There are several continuous series available on DataStream (TRC1 – TRC6). This allows for straightforward study, as DataStream’s TRC1 “rolls” in an identical fashion to that of the S&P GSCI’s internal methodology. There is, therefore, no need to emulate the S&P GSCI’s “rolling” methodology and manipulate the data as if it were in its raw form.

The S&P GSCI methodology ensures a continuous price series by considering the price levels of the first nearby futures contract for each indexed commodity (S&P Dow Jones Methodology, 2023), and as a particular commodity futures contract approaches delivery or expiration, the S&P GSCI’s long position in that commodity is “rolled” into the next nearest eligible contract on the last trading day of the previous contract, using the respective daily settlement prices (Peterson, 2013). The S&P GSCI therefore treats the old, expired futures contract and the new futures contract which has replaced it as perfect substitutes (Peterson, 2013). The S&P GSCI needs to ensure its continuity to allow for value comparisons of the S&P GSCI over time. Access to a continuous daily futures price series such as DataStream’s TRC1 also allows for comparative analysis of returns between various futures prices and with daily closing spot prices.

One critical feature required in futures markets is daily mark-to-market (MTM) prices for all futures contracts, requiring the exchange to carry out a daily settlement of all gains and losses so long as a futures contract remains open (CME Group, 2024). The daily settlement price for various commodity futures is, in this way, the same for all participants. Standardization is an important characteristic of futures contracts. Homogeneity and well specified contracts support the smooth facilitation of large trading volumes on futures markets within organised exchanges. Daily settlement prices, by ‘marking’ trading positions to the ‘market’ daily, determine whether trader positions had gains or losses on a particular day (CME Group, 2024). Daily settlement prices are reflective of the fair market value for an underlying commodity (CME Group, 2024), and are established according to the trading activity of buyers and sellers during a point in time known as the "settlement period" or the "daily close". Futures always have an official daily settlement price set by the exchange. These prices are those quoted in the financial news for items like a future bushel of wheat or a future barrel of crude oil. While each commodity future may have a unique process for determining a settlement price, the exchange's objective is the same across all commodity futures, and that is to ensure the safety and integrity of the market (CME Group, 2024).

As soon as a future contract's daily settlement price has been established then all trade reporting, trading profits/losses and trading margin adjustments are made as part of the exchange's back-office functioning. It is in this way that no losses are carried forward, and instead they are be cleared daily (CME Group, 2024). The difference from the previous day's settlement price to the next day's settlement price determines the traders' profit or loss. If a daily loss results in net equity falling below the preferred margin levels specified by the exchange, the trader is then required to provide additional finances to replenish the account back to required levels or risk the exchange liquidating the trader's position (CME Group, 2024 This is why the mark-to-market approach in futures markets is an important enforcer of daily discipline expected of the commodity exchanges, which, amongst other things, eliminates the risk of the clearinghouse being in jeopardy. It is in this way that having one daily settlement value for all ensures that all open trading positions are treated equally (CME Group, 2024). Publication of daily settlement values means that the exchange is facilitating an important and credible price referential for the underlying futures. This serves both commercial and speculative (financial) participants of the futures markets, as well as the underlying physical market participants. The daily settlement prices facilitating the critical functions of price discovery and risk management (hedge), thereby uphold market integrity (CME Group, 2024).

It is for these reasons that this empirical analysis uses daily settlement prices of commodity futures data points. Following the methods of Tang and Xiong (2012), Mann and Keeton (2013), Ndawona *et al.* (2019), other papers which used similar data sets include Bohl, Irwin, Putz and Sulewski (2023), Gross (2017), Bakshi, Gao and Rossi (2014), Kristoufek and Vosvrda (2014), Lauter, Prokopczuk and Truck (2023), and Le Roux (2017).

Table 4: Commodity spot prices used in the analysis.

Commodity	Original Data Description	Source (Thompson Reuters Eikon DataStream)
Energy		
WTI Crude Oil Spot	Cushing OK WTI Spot FOB U$/BBL	Energy Information Administration
Brent Crude Oil Spot	Brent EU Spot FOB U$/BBL	Energy Information Administration
Heating Oil Spot	NY Harbour No.2 Heating Oil Spot Price FOB U$/gallon	Energy Information Administration
Industrial Metals		
Aluminium Spot	99.7% Aluminium Cash USD / mt Daily	London Metal Exchange
Copper Spot	Grade A Copper Cash USD / mt Daily	London Metal Exchange
Nickel Spot	Nickel Cash USD / mt Daily	London Metal Exchange
Lead Spot	Lead Cash USD / mt Daily	London Metal Exchange
Zinc Spot	Special High-Grade Zinc 99.995% Cash USD / mt Daily	London Metal Exchange
Tin Spot	Tin 99.85% Cash USD / mt Daily	London Metal Exchange
Precious Metals		
Gold Spot	Gold Bullion Price Daily USD / troy ounce	Handy & Harman
Silver Spot	Silver Bullion Price Daily USD / troy ounce	Handy & Harman
Platinum Spot	London Platinum Free Market $ / troy oz Daily	London Metal Exchange
Palladium Spot	Palladium $ / troy ounce Daily	London Metal Exchange

Table 5: Additional variables used in the analysis.

Additional Variables	Original Data Description	Source (Thompson Reuters Eikon DataStream)
S&P GSCI Index	S&P GSCI Commodity Index – Index (OFCL) USD	Standard & Poor Global Ratings, Goldman Sachs Group
MSCI Emerging Markets Index	MSCI EM U$ - Price Index USD	Morgan Stanley Capital International
MSCI World	MSCI World U$ - Price Index USD	Morgan Stanley Capital International
MSCI South Africa	MSCI South Africa – Price Index USD	Morgan Stanley Capital International
S&P 500 Composite	S&P 500 Composite – Price Index USD	Standard & Poor Global Ratings
Dow Jones Industrial Average	Dow Jones Industrials – Price Index USD	Dow Jones & Company
US 10 Year Government Bond	US Benchmark 10 year Govt Index – Price Index USD	Thompson Reuters Eikon DataStream
US Dollar Index	US Dollar Index DXY – Price Index USD	Intercontinental Exchange Data Services

The commodity spot prices used in the analysis are daily closing prices and all additional variables are also daily closing prices, all of which are in USD. It should be noted that given the difficulty in retrieving spot prices for some commodities, the spectrum of spot commodities is narrower relative to that of futures in this analysis. For example, in the energy sector, spot prices were available only for WTI crude oil, Brent crude oil and heating oil, meaning that spot prices for natural gas and gas oil are not included and therefore the sector average return correlation for the energy complex is not entirely reflective of the entire spectrum of energy commodities weighted in major indices. The precious metals and industrial metals spot prices with indexed futures counterparts were available and are included. No spot prices were available for the grains, softs and livestock sectors.

3.3. Correlation

The term 'correlation coefficient' was first coined by Karl Pearson in 1896 (Ratner, 2009), and is a staple method used in data analytics. The correlation method is a foundational technique for statistical analysis used to detect relationships between variables (Reach, 2009). The correlation method is used to discover whether a relationship exists amongst two or more variables, indicating the strength of the relationship based on the distribution of the results along the coefficient interval from -1 to +1.

The following points from Ratner (2009:17-18) serve as necessary guidelines for interpretation of the correlation coefficient:

1. "0 suggests no linear relationship.
2. + 1 indicates a perfect positive linear relationship, the other variable also increases in its values through an exact linear rule.
3. – 1 indicates a perfect negative linear relationship - as one variable increases in its values, the other variable decreases in its values through an exact linear rule.
4. Values between 0 and 0.3 (or 0 and - 0.3) indicate a weak positive (negative) linear relationship.
5. Values between 0.3 and 0.7 (or - 0.3 and - 0.7) indicate a moderate positive (negative) linear relationship.
6. Values between 0.7 and 1.0 (or – 0.7 and – 1.0) indicate a strong positive (negative) linear relationship."

The correlation coefficient's weaknesses and cautioning around misuse are well documented. (Beaumont, 2012). If a significant relationship is identified through the correlation analysis techniques it does not necessarily imply that there is causation between variables. Correlation analysis results can suggest, however, whether there is a significant relationship and whether that relationship has changed over time, which are preconditions for further study into measuring causation (Beaumont, 2012) through other means of statistical analysis. In summary, the use and application of correlation-based statistical analysis, especially considering the nature of this research, is intended to help identify which variables are dependent on each other and how these relationships may have changed. The results can generate some insights and serve as a conceptual springboard for further investigation and research.

3.3.1. Rolling Return Correlation

A 12-month rolling return correlation method is used for daily changes (returns) in futures and spot prices, and other comparative data points. The 1-year rolling correlation of daily returns between two time series is calculated, in line with the methodology used by Tang and Xiong (2012), Mann and Keeton (2013), and Ndawona *et al.* (2019).

The Microsoft Excel function "CORREL", which calculates the correlation coefficients between two data sets, is represented in the following way:

$$CORREL\ (X,Y) = \frac{\Sigma(x-\bar{x})(y-\bar{y})}{\sqrt{\Sigma(x-\bar{x})^2(y-\bar{y})^2}} \qquad \text{Equation 1.1}$$

$\bar{x}\ and\ \bar{y}$ are samples means.

Based on previous empirical methodology (Bichetti and Maystre, 2012, Tang and Xiong, 2012, Mann and Keeton, 2013, Ndawona *et al*, 2019, Kang, Tang and Wang, 2023), the investigation of commodity financialisation and its impact on commodity prices is extended to include more of the exchange traded commodity futures found in major commodity indices as well as the available corresponding spot prices for the precious metal, industrial metal and energy sectors. Exchange traded commodity futures not weighted in the S&P GSCI, such as tin, palladium, oats and orange juice are also included, hereafter referred to as non-indexed commodities. Some additional data points, including the S&P 500, Dow Jones Industrial Average, MSCI World, MSCI Emerging Markets, MSCI South Africa, a US 10-year Bond Index and the US Dollar Index are included to test for cross market and cross asset return correlations with the S&P GSCI.

The period under investigation has also been extended to include the 2020-2024 period, which includes the COVID-19 event, and the quick financial rebound and bullish momentum seen in commodity and equity markets after the COVID-19 market lows. The 2020-2024 period is an important period for comparative analysis against results found in previous commodity market price upswings by Bichetti and Maystre (2012), Tang and Xiong (2012) and Mann and Keeton (2013). It is important to establish whether the previously found rising return correlation between different commodity spot prices and between futures prices in the 2000-2011 upswing occurred again in the 2020-2024 period of rising prices. The entire analysis period is thus from 3 January 1994 to 18 April 2024.

Rolling return correlations are first calculated for Period 1 (pre-financialisation), which is from January 1994 to December 1999, and then Period 2 (post-financialisation), which is from January 2000 to April 2024. Period 2 (a), a period with a significant price upswing, or better known as the commodity (bull) super cycle, represents January 2000 to December 2011. Period 2 (b), a period with a price downswing from 2012 – 2016 and then a mostly flat trend after that, represents January 2012 to December 2019. Period 2 (c) represents January 2020 to April 2024, a period with a significant downturn at the onset of the pandemic and then a rapid price upswing and recovery off the 2020 Covid-19 market lows.

The rolling return correlation method is first used to calculate return correlation for pairs of commodity futures in the same commodity sector (e.g. energy or industrial metals), and then for pairs of commodity spot prices in the same sector, to measure and compare how the return correlations between commodities in the same sector may have changed over time. Rolling return correlations are then calculated for pairs of futures prices of commodities across different sectors, and then spot prices of commodities across different sectors. The rolling return correlation method is also used to measure the cross-market and cross-asset return correlation structure between the S&P GSCI Index and global equity indices, and investor sentiment indices. The S&P GSCI Index is used as a benchmark for commodity market returns which can be compared to the returns of a regular equity investment like the S&P 500.

According to Stoll and Whaley (2010:9) the reason for this methodological approach is: "Commodity index investing is a mechanical trading strategy based on a set of well-defined and well-known set of rules. Net funds flowing into commodity index investments are immediately redeployed into the commodity index futures market through the simultaneous purchase of all index commodities. If commodity index trades are large enough to push prices upward, the prices in all markets should move upward concurrently. Put differently, the returns of all futures contracts used in index replication should be highly correlated".

A similar hypothesis is adopted to answer the primary research question of this thesis. Specifically, if excessive institutional investment into commodity indices and commodity financialisation played and is playing a significant role in commodity futures markets, it is expected that the returns of indexed commodity futures will on average be more highly correlated in the 'post-financialisation' period of 2000–2024, as compared to the 'pre-financialisation' period of 1994–1999. In addition, this thesis investigates whether findings of previous researchers confirming heightened correlation in the returns of indexed commodity futures in the early stages of the commodity financialisation period can also be seen in the returns of commodity spot prices which have futures counterparts weighted in major commodity indices. If financialisation is important it is expected that returns of commodity spot pairs with indexed futures counterparts will also be found on average to be more highly correlated in the 'post-financialisation' (2000-2024) period compared to the 'pre-financialisation' (1994-1999) period. This expectation is rooted in the theoretical underpinnings and fundamental dynamics between futures markets and spot markets. It is expected that pairs of indexed futures as well as spot pairs with futures counterparts will show relatively low and insignificant return correlation in Period 1 (pre-financialisation).

Furthermore, if financialisation is important it is expected that pairs of futures with one being indexed and the other, non-indexed, may show less significant changes in return correlation in Period 2 (post-financialisation), compared to Period 1 (pre-financialisation). Similarly, it is expected that spot pairs with one futures counterpart weighted in a major commodity index and the other, having a non-indexed futures counterpart, may show less significant changes in return correlation in Period 2 (post-financialisation), compared to Period 1 (pre-financialisation).

3.4. Stationarity Tests

Economic and financial time series often have random walks which cause issues such as time-variant mean, variance and covariance to manifest (Gujarati, 2009). This can result in the probability distribution of time series variables being unstable, and it is said that such variables are non-stationary and have unit root problems (Gujarati, 2009). The credibility of statistical inference is lost when a non-stationary series is regressed on another stationary or non-stationary series. Results are spurious, unless the two series are of the same order of integration (Gujarati, 2009). The stationarity tests are therefore an important informant as to how this paper's multiple regression model was estimated.

The first test used is the Augmented Dickey-Fuller (ADF) unit root test. This test was developed as advancement of the original Dickey-Fuller test to account for the cases where the error term was correlated (Gujarati, 2009). The ADF test's objective is to test the null hypothesis that the time series has a unit root ($\delta = 0$) against the test's alternative hypothesis that the time series is stationary ($\delta < 0$) (Gujarati, 2009).
The ADF test consists of estimating the following regression (Gujarati, 2009):

$$\Delta \mathbf{Y}\text{t} = \beta_1 + \beta_2 t + \delta Y_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta Y_{t-1} + \varepsilon_t \qquad \text{Equation 1.2}$$

where ε_t is a pure white noise error term.

The second test used is the Phillips-Perron unit root test. Perron (1988) proposed an alternative non-parametric statistical method to control for serial correlation in the error terms without needing to include lagged difference terms such as in the ADF test (Gujarati, 2009). The Phillips-Perron test's the null hypothesis that a time series has a unit root, and the alternative hypothesis is that the time series is stationary.

The Phillips-Perron test is based on the following statistic (EViews12, 2020):

$$t_a = t_\alpha \left(\frac{\gamma_0}{f_0}\right)^{1/2} - \frac{T(f_0 - \gamma_0)(se(\hat{\alpha}))}{2f_0^{1/2}s} \qquad \text{Equation 1.3}$$

All stationarity testing began by testing for stationarity in level terms, firstly without drift and trend, then with only drift, and lastly, with drift and trend. If the time series was found to be non-stationary in level terms, then the series is first differenced and re-tested firstly without drift and trend, then with drift only, and lastly, with drift and trend.

3.5. Multiple Regression

The modern interpretation and applications are quite different, where regression analysis involves the study of the dependence of one variable, the dependent variable, on one or multiple explanatory variables, by estimating the average value of the dependent variable in terms of values of the explanatory variables (Gujarati, 2009). Multiple regression can help determine to what degree the total variation of the dependent variable is influenced or explained by the variation of the independent variables.

The multiple regression used in the study holds the following form:

$$\Upsilon_i = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \cdots + \beta_p x_{ip} + \epsilon \qquad \text{Equation 1.4}$$

and:

i = 1,2,….., n are observations from the data sample

Υ_i = the dependent variable

x_i = explanatory variables

β_0 = y-intercept, or constant term

β_p = slope coefficients for each explanatory variable

ϵ = the model's error term, or residuals

Commodity market spot price returns were chosen as the dependent variable, based on theoretical motivation about the direction of causation between futures and spot. Because the objective of the analysis is to determine whether changes in futures prices because of financialisation are impacting on spot prices, returns of the nearest to maturity futures contract prices are included as an explanatory variable given that the S&P GSCI utilises these prices for its index construction and continuity. The MSCI Emerging Markets Index returns and US Dollar Index returns were also included as explanatory variables to control for the effects that commodity demand from emerging economics, and effects of international investors, respectively, may have on spot market returns. The returns of the S&P 500 Index and the US 10-year Bond Index were included as explanatory variables to control for the potential effects which macroeconomic fundamentals and investor risk appetite may have on spot market returns. Both the US 10-year Bond Index and the US Dollar Index are usually seen as investment safe havens in a flight-to-safety scenario (Kang, Tang and Wang, 2023). When investors want to reduce exposure and manage risk in the equity markets during periods of volatility, or if investors expect a downturn in equities due to unfavorable future economic environment, they may find "safety" in the US dollar and (or) lock in a guaranteed fixed rate of return by buying US 10-year bonds. These two variables can therefore serve as alternative barometers for equity investor sentiment and risk-aversion. Ideally, the CBOE Volatility (VIX) Index would also be a good gauge equity investor risk aversion and sentiment, but unfortunately a continuous data series was unavailable through Rhodes University's access to the Thompson Reuters (Eikon) 'DataStream' online database.

WTI crude oil, gold, silver, LME copper and aluminium were chosen as the commodities to include in the multiple regression analysis as they offer insights into the energy, precious metal and industrial metal sectors. All five of these commodities are prominent commodities within commodity markets and overall global trade, factors which informed the decision to include them in the regression analysis.

The data used in the multiple regression analysis has been transformed into daily logarithmic returns. It is well known that the probability distribution of high frequency financial returns data is most often characterised by a leptokurtic, fat and heavy tailed distribution (So, Chen, Lee and Chang, 2008). Given that these types of data sets tend to be leptokurtic, we rely on standardised coefficients, and so, the coefficients reported in Chapter 4's multiple regression results have been standardized, so that they follow a normal distribution. In addition to this, because time series data such as high frequency financial returns tends to be non-conforming to standard assumptions of regression analysis (Taylor, 2008), the Newey-West Estimator is incorporated into the regression. The Newey-West adjustment is a standard procedure used by econometricians to correct for heteroskedasticity and serial correlation in time series models (Mei and Newey, 1994).

It is important to be cautious of potential endogeneity issues and how they may affect the results of this multiple regression analysis. Endogeneity issues may arise due to omitted variable bias, simultaneity or reverse causality. Omitted variable bias may significantly impact the results of the multiple regression analysis when a relevant variable that is highly correlated with both the dependent and one or more of the independent variables is left out of the model. Such a variable being omitted from the model may result in the effect of the omitted variable being falsely attributed to one or more of the included independent variables, leading to a distortion of estimates of the relationships which exist between the variables. Simultaneity occurs when a two-way causal relationship between the dependent and one or more of the independent variables in a regression model, and so the dependent variable may influence one or more of the independent variables, and those independent variables also influence the dependent variable. The estimated coefficients in a multiple regression model may become biased in the presence of simultaneity. Reverse causality occurs when the dependent variable influences the independent variable, rather than the independent variable affecting the dependent variable, as assumed in a regression model. Results may be inconsistent in the presence of reverse causality. Indeed, futures and spot market price returns may have reverse causality.

In the initial phase of the analysis, a Vector Auto Regressive (VAR) model was used, but it suffered from many econometric problems and so a simpler regression model was used to provide a causal explanation. Although there is potential for reverse causality in the model and an element of bias in the results, it will probably not change the direction or strength of the causation.

Two academic papers were found which informed the decision to use a regression model to establish causality. Raghavendra and Velmurugan (2016) investigated the relationship between spot and futures prices of agricultural commodities and used multiple regression models to analyse the lead-lag relationships and causality between spot and futures markets. Amoah (2021) explored the causal linkages between commodity spot and futures markets by applying Ordinary Least Squares (OLS) regressions to assess the direction and strength of the relationships.

3.6. Conclusion

This chapter explained the data, data sources and methodologies used in conducting this research. As employed in previous studies such as Stoll and Whaley (2010), Bichetti and Maystre (2012), Tang and Xiong (2012), Mann and Keeton (2013), Bonato and Taschini (2015), Ndawona *et al.* (2019), and Kang, Tang and Wang (2023), the method of calculating rolling return correlation is adopted in this study. In addition, a multiple regression model is utilized to better understand both the relationship between the dependent variable and explanatory variables, and the extent to which the total variation of spot market returns is influenced by, and explainable through the variation of the explanatory variables.

CHAPTER 4:

EMPIRICAL ANALYSIS AND FINDINGS

4.1. Introduction

The empirical results are presented in this chapter, which is structured in the following way: Section 4.2 presents the results for Method 1, the rolling return correlation analysis. Section 4.3 begins by presenting the descriptive statistics, then the results of the ADF and Phillips-Perron stationarity tests, and this is then followed by the results for Method 2, the multiple regression analysis. Section 4.4 concludes Chapter 4.

4.2. Method 1: Rolling Return Correlation

A sample of the results for the rolling return correlation method are tabulated and presented in subsections 4.2.1 – 4.2.7. Average return correlation and changes in average rolling return correlation results are shown for the different time periods. Average return correlation results across time periods are preferred instead of reporting the changes in return correlation between the start and the end of periods. This is because when changes in average correlation between time periods are substantial, the results can be considered empirically important given that change is after the flattening and dilution effect associated with period averaging in large data sets. Tabulated results of all commodity pairs can be found in Appendix A. Appendices B-F provide graphical illustrations of the changes in return correlation across the entire sample period for all pairs of commodities shown numerically in Appendix A. The graphical illustrations are helpful to understanding the trend in return correlations over time. Reviewing the graphical illustrations complements the interpretation of the tabulated results in Appendix A.

4.2.1. Pairwise rolling return correlation of futures prices in the same sector

Table 6 displays results for a sample of pairs of indexed commodities in the same sector. The tabulated results for all 71 pairs of commodity futures in the same sector can be found in Appendix A, Tables A1-A8, and graphical illustrations can be found in Appendix B. Of the 71 pairs, 17 include one non-indexed commodity future and one which is indexed. Commodity futures classified as non-indexed (i.e. not weighted in any of the three major commodity indices) include palladium, tin, orange juice and oats. All the other commodities analysed are part of the baskets of commodities included in the global commodity indices bought by investors. It is expected that because of commodity market financialisation the return correlation between indexed futures in the same sector in Period 2 (post-financialisation) will rise as index investors simultaneously buy futures of both commodities. Alternatively, when one commodity is indexed and the other commodity in the same sector is not indexed, there is no reason to believe that the return correlation will change as only the indexed future is bought. Furthermore, the change in return correlation is expected to be greatest in Period 2(a) (2000-2011) as this is when, because of the belief in the commodity super cycle, investor interest in buying commodities was the greatest. The change in return correlation in Period 2(b) (2012-2019) is expected to remain significantly higher compared to Period 1(pre-financialisation), but to a lesser degree than Period 2(a) (2000-2011). However, Period 2(c) (2020-2024) is expected to show significant changes in return correlation, comparable to Period 2(a) (2000-2011), as commodity prices have shown strong upward momentum since the 2020 Covid-19 market lows.

Table 6 simplifies the findings discussed in more detail below by comparing the average return correlations for pairs of indexed commodity futures by sector, across the pre- and post-financialisation sub-periods. Results for Table 6 were calculated using the rolling return correlation results in Tables A1-A6 in Appendix A.

Table 6: Rolling return correlation results for pairs of commodity futures in the same sector

	Gold vs Silver	WTI vs Gas Oil	Brent vs Nat Gas	LME Cop vs Alum	LME Cop vs Zinc	Soyb vs Kans Wheat	Live Cattle vs Lean Hogs	Cotton vs Sugar
Period 1 (pre-financialisation)	0.615	0.427	0.101	0.489	0.408	0.284	0.051	0.021
Period 2 (post-financialisation)	0.769	0.547	0.186	0.615	0.621	0.377	0.107	0.146
Period 2 - Period 1	0.155	0.119	0.085	0.126	0.213	0.093	0.056	0.126
% Change: P1 to P2	**25.168**	**27.905**	**84.362**	**25.742**	**52.131**	**32.836**	**109.198**	**609.555**
Period 2 (a)	0.728	0.531	0.284	0.700	0.629	0.394	0.140	0.145
Period 2 (a) - Period 1	0.114	0.104	0.183	0.211	0.221	0.110	0.089	0.124
% Change: P1 to P2 (a)	**18.548**	**24.272**	**181.903**	**43.089**	**54.168**	**38.852**	**174.018**	**602.949**
Period 2 (b)	0.821	0.590	0.087	0.532	0.638	0.347	0.069	0.112
Period 2 (b) - Period 1	0.206	0.163	-0.013	0.043	0.229	0.063	0.018	0.092
% Change: P1 to P2 (b)	**33.593**	**38.090**	**-13.397**	**8.722**	**56.218**	**22.217**	**36.214**	**444.435**
Period 2 (c)	0.786	0.509	0.095	0.534	0.567	0.385	0.084	0.213
Period 2 (c) - Period 1	0.172	0.082	-0.006	0.044	0.159	0.102	0.033	0.193
% Change: P1 to P2 (c)	**27.963**	**19.099**	**-5.910**	**9.005**	**38.847**	**35.804**	**64.126**	**935.122**

Notes:
Period 1 (January 1994 to December 1999) and Period 2 (January 2000 and April 2024) represent the pre-financialisation period and post financialisation period, respectively. Period 2 is divided into three subperiods: Period 2 (a), Period 2 (b) and Period 2 (c). Period 2 (a) is from January 2000 to December 2011. Period 2 (b) is from January 2012 to December 2019. Period 2 (c) is from January 2020 to April 2024.
Source: Author's own calculations

4.2.1.1. Period 2 versus Period 1

The results for Period 2 as whole (post-financialisation) are in line with expectations that correlations between indexed futures will rise because financial investors buy all indexed commodities simultaneously. There is a substantial increase in return correlations in Period 2 (post-financialisation) compared to Period 1 (pre-financialisation) for all pairs of indexed commodity futures in the same sector. Of the 54 pairs of indexed commodity futures, 49 of the pairs (or 90%) showed increased return correlation in Period 2 (post-financialisation) versus Period 1 (pre-financialisation). Of the 49 pairs which showed increased return correlation in Period 2 (post-financialisation) versus Period 1 (pre-financialisation), 38 of the pairs showed increased return correlation of more than 10%, and 28 of the pairs increased by more than 20%. Some of the most significant increases in return correlation for pairs of indexed commodities in Period 2 (post-financialisation) compared to Period 1 (pre-financialisation) are between the returns for coffee and sugar (+1521.71%), coffee and cotton (+294.18%), cotton and sugar (+609.56%), live cattle and lean hogs (+109.20%), Brent crude oil and natural gas (+84.36%), gas oil and natural gas (+67.38%), natural gas and heating oil (+32.54%), CMX copper and lead (+66.44%), CMX copper and zinc (+84.48%), and LME copper and zinc (+52.13%). Exceptions to this were gold and platinum (-3.65%), lean hogs and feeder cattle (-32.99%), and sugar and cocoa (2.41%).

It is expected that pairs where one is an indexed commodity and the other is a non-indexed commodity in the same sector will be unaffected by financialisation in Period 2 because non-indexed commodities are not included in fund buying. Such pairs may therefore show rising, falling or unchanged return correlations in Period 2 (post-financialisation) compared to Period 1 (pre-financialisation). Examples which confirmed these expectations include corn and oats (-30.50%), cocoa and orange juice (-39.782%), and soybeans and oats (-32.11%). In some cases, the opposite was found, and return correlation rose, this includes sugar and orange juice (+291.36%), silver and palladium (+56.79%), and LME copper and tin (+49.18%).

4.2.1.2. Period 2(a) versus Period 1

Regarding Period 2(a) (2000-2011), known as the commodity boom or super cycle, the results are mostly as expected and confirm what has previously been found in the literature for this period (Tang and Xiong, 2012, Mann and Keeton, 2013, Ndawona *et al.* 2019). Return correlations for pairs of indexed commodity futures almost all showed substantial increases in correlation in Period 2(a) (2000-2011) compared to Period 1 (pre-financialisation). Of the 54 pairs of indexed commodity futures, 48 of the pairs (or 89%) showed increased return correlation in Period 2(a) (2000-2011) versus Period 1 (pre-financialisation). Of the 48 pairs which showed increased return correlation in Period 2(a) (2000-2011) versus Period 1 (pre-financialisation), 42 of the pairs showed increased return correlation of more than 10%, and 31 of the pairs increased by more than 20%. Pairs of indexed commodity futures that show the largest increases in return correlation in Period 2(a) (2000-2011) compared to Period 1 (pre-financialisation) include WTI crude oil and natural gas (+178.71%), gas oil and natural gas (+151.23%), natural gas and heating oil (+96.94%), CMX copper and lead (58.36%), CMX copper and zinc (81.62%), LME copper and lead (+63.16%), LME copper and zinc (+54.17%), LME copper and aluminium (43.09%), live cattle and lean hogs (+174.02%), soybeans and Kansas wheat (+38.85%), Chicago wheat and soybean oil (+74.77%), cotton and sugar (+602.95%), and coffee and cotton (+318.99%). Exceptions to the finding of rising correlations were gold and platinum (-33.10%), silver and platinum (-27.82%), live cattle and feeder cattle (-3.04%), and lean hogs and feeder cattle (-18.84%).

For pairs with one indexed commodity and the other, a non-indexed commodity, returns fell or rose in confirmation with the expectation that financialisation would not impact on non-indexed commodities. Correlations fell for corn and oats (-19.75%), soybean and oats (-19.55%), soybean meal and oats (-24.38%), and Chicago wheat and oats (-5.37%), but rose for gold and palladium (+19.55%), silver and palladium (+45.31%), platinum and palladium (+7.20%), LME copper and tin (58.27%), lead and tin (+12.63%), nickel and tin (9.80%), zinc and tin (+11.39%), aluminium and tin (+12.06%), coffee and orange juice (+128.47%), cotton and orange juice (+183.682%), sugar and orange juice (+207.38%).

Overall, the results confirm that returns for pairs of indexed commodity futures are more highly correlated in Period 2(a) (2000-2011) compared to Period 1 (pre-financialisation). This is evident across all sectors.

4.2.1.3. Period 2(b) versus Period 1

Period 2(b) (2012-2019), a period of initially declining and then mostly flat commodity prices, shows results in line with expectations. Return correlations for pairs of indexed commodity futures almost all rose in Period 2(b) (2012-2019) compared to Period 1 (pre-financialisation). Of the 54 pairs of indexed commodity futures, 44 of the pairs (or 81%) showed increased return correlation in Period 2(b) (2012-2019) versus Period 1 (pre-financialisation). Of the 44 pairs which showed increased return correlation in Period 2(b) (2012-2019) versus Period 1 (pre-financialisation), 34 of the pairs showed increased return correlation of more than 10%, and 27 of the pairs increased by more than 20%. Pairs of indexed commodity futures that show the most significant increases in return correlation in Period 2(b) (2012-2019) compared to Period 1 (pre-financialisation) include gold and silver (+33.59%), gold and platinum (+33.60%), silver and platinum (47.37%), WTI crude oil and gas oil (+38.09%), brent crude oil and gas oil (+30.47%), CMX copper and lead (98.96%), CMX copper and nickel (+42.21%), CMX copper and zinc (+90.01%), LME copper and lead (+65.72%), coffee and cotton (+259.88%), coffee and sugar (+1964.44%), coffee and cocoa (+106.52%), cotton and sugar (+444.44%), and cotton and cocoa (+163.86%). However, exceptions to this were Brent crude oil and natural gas (-13.40%), gas oil and natural gas (-31.59%), natural gas and heating oil (-34.80%), lean hogs and feeder cattle (-54.54%), corn and soybean oil (-2.51%), corn and soybean meal (-3.54%), soybeans and soybean oil (-11.73%), Kansas wheat and soybean oil (-4.00%), soybean oil and soybean meal (-32.40%), and sugar and cocoa (-22.47%).

For pairs with one indexed commodity and the other, a non-indexed commodity, correlations fell for aluminium and tin (-8.44%), corn and oats (-36.95%), soybeans and oats (-43.99%), Chicago wheat and oats (-8.96%), Kansas wheat and oats (-11.52%), soybean oil and oats (-50.04%), soybean meal and oats (-45.61%), and cocoa and orange juice (-40.97%), but rose for gold and palladium (+19.55%), silver and palladium (+45.31%), platinum and palladium (+7.19%), CMX copper and tin (+40.29%), LME copper and tin (+39.34%), zinc and tin (+10.15%), coffee and orange juice (+15.28%), cotton and orange juice (177.74%), and sugar and orange juice (+176.82%).

Overall, the results strongly suggest that the returns for pairs of indexed commodity futures remained substantially higher in Period 2(b) (2000-2011) compared to Period 1 (pre-financialisation). This is evident across all sectors.

4.2.1.4. Period 2(c) versus Period 1

Period 2(c) (2020-2024) is characterized by an initial sharp downturn in both commodity and equity markets at the onset of the Covid-19 pandemic, and then shortly thereafter, a very strong rebound and recovery rally off the market lows. Arguably, commodities have been in a sustained bull market since the 2020 Covid-19 lows. Period 2(c) (2020-2024) therefore is an important period for comparative analysis against Period 2(a) (2000-2011) to see whether the higher correlations experienced during the super cycle Period 2(a) when funding buying was very strong were replicated in the more recent bull market.

The results show that pairs of indexed commodity futures have higher return correlations in Period 2(c) (2020-2024) compared to Period 1 (pre-financialisation), although it appears that correlations are not quite as high as in Period 2(a) (2000-2011) and Period 2(b) (2012-2019). As in previous periods, return correlation for pairs of indexed commodity futures mostly showed increases in correlation in Period 2(c) (2020-2024) compared to Period 1 (pre-financialisation). Although, in the case of Period 2(c) (2020-2024), there were notably more exceptions to this than in post-financialisation Period 2(a) (2000-2011) and Period 2(b) (2012-2019).

Of the 54 pairs of indexed commodity futures, 34 of the pairs (or 63%) showed increased return correlation in Period 2(c) (2020-2024) versus Period 1 (pre-financialisation). Of the 34 pairs which showed increased return correlation in Period 2(c) (2020-2024) versus Period 1 (pre-financialisation), 24 of the pairs showed increased return correlation of more than 10%, and 15 of the pairs increased by more than 20%. Some of the most significant increases in return correlation for pairs of indexed commodity futures in Period 2(c) (202-2024) compared to Period 1 (pre-financialisation) were between the returns for CMX copper and aluminium (+82.21%), gas oil and heating oil (+33.52%), silver and platinum (+36.87%), LME copper and zinc (+38.85%), live cattle and lean hogs (+64.13%), soybeans and Kansas wheat (+35.80%), coffee and cotton (+288.76%), coffee and sugar (+1375.27%), coffee and cocoa (+111.75%), cotton and sugar (935.12%), and cotton and cocoa (+166.99%).

Falling correlations were found for WTI crude oil and natural gas (-50.37%), WTI crude oil and heating oil (-7.75%), Brent crude oil and natural gas (-5.91%), natural gas and heating oil (-21.86%), LME copper and nickel (-16.97%), lead and nickel (36.76%), lead and zinc (-12.51%), lead and aluminium (-18.86%), nickel and aluminium (-27.65%), live cattle and feeder cattle (-8.17%), lean hogs and feeder cattle (-32.35%), corn and soybean meal (-22.34%), corn and soybean oil (-3.51%), soybeans and soybean meal (-15.59%), Chicago wheat and soybean meal (-6.93%), Kansas wheat and soybean meal (-3.56%), and soybean oil and soybean meal (-72.78%).

Findings for pairs with one indexed commodity and the other, a non-indexed commodity are again mixed. Falling correlations in Period2(c) (2020-2024) compared to Period 1 (pre-financialisation) include lead and tin (-15.72%), nickel and tin (-12.93%), aluminium and tin (-9.54%), corn and oats (-48.51%), soybeans and oats (-45.04%), Chicago wheat and oats (-33.77%), Kansas wheat and oats (-28.49%), soybean oil and oats (-38.28%), soybean meal and oats (-62.93%), and cocoa and orange juice (-206.12%). Correlations rose for gold and palladium (+33.09%), silver and palladium (+66.47%), platinum and palladium (+42.59%), CMX copper and tin (+55.06%), LME copper and tin (+45.87%), zinc and tin (+13.21%), coffee and orange juice (+195.03%), cotton and orange juice (+167.10%), and sugar and orange juice (+738.65%).

Overall, the results suggest that returns for pairs of indexed commodity futures are mostly more highly correlated in Period 2(c) (2020-2024) compared to Period 1 (pre-financialisation), although the extent of the increase in return correlation relative to Period 1 (pre-financialisation) appears to be less than in the other post-financialisation periods, Period 2(a) (2000-2011) and Period 2(b) (2012-2019).

4.2.1.5. Changes in return correlation of futures prices by sector

In Table 7 all sectors show a higher level of return correlation for pairs of indexed commodities in Period 2 (post-financialisation) compared to Period 1 (pre-financialisation). The largest increases in return correlation between Period 2 (post-financialisation) and Period 1 (pre-financialisation) are seen in the softs (+450%), industrial metals (+25.9%), energy (+21.46%) and precious metal (+11.05%) sectors, whereas the increase in the livestock sector is small (+1.38%).

In Period 2(a) (2000-2011), all sectors, except for precious metals (-11.43%), show an increase in return correlation compared to Period 1 (pre-financialisation). In Period 2(b) (2012-2019), all sectors, except for livestock (-2.29%), show higher return correlation relative to Period 1 (pre-financialisation). In Period 2(c) (2020-2024), return correlation has increased compared to Period 1 (pre-financialisation) for softs (+457.69%), precious metals (+24.57%), energy (+8.54%) and industrial metals (+5.04%), but fell for livestock (-8.26%) and grains (-2.33%).

Interestingly, compared to Period 2(a) (2000-2011) and Period 2(b) (2012-2019), return correlation is significantly lower in Period 2(c) (2020-2024) for the energy, industrial metals, livestock and grains sectors.

Table 7: Sector Average Return Correlation for Pairs of Indexed Commodity Futures

	Precious Metals	Energy	Industrial Metals	Livestock	Grains	Softs
Period 1 (pre-financialisation)	0.525	0.410	0.417	0.218	0.429	0.026
Period 2 (post-financialisation)	0.583	0.498	0.525	0.221	0.485	0.143
% Change from P1 to P2	**11.05%**	**21.46%**	**25.90%**	**1.38%**	**13.05%**	**450%**
Period 2 (a)	0.465	0.528	0.542	0.233	0.524	0.148
% Change from P1 to P2 (a)	**-11.43%**	**28.78%**	**29.98%**	**6.88%**	**22.15%**	**469.23%**
Period 2 (b)	0.722	0.481	0.547	0.213	0.457	0.132
% Change from P1 to P2 (b)	**37.52%**	**17.32%**	**31.18%**	**-2.29%**	**6.53%**	**407.69%**
Period 2 (c)	0.654	0.445	0.438	0.200	0.419	0.145
% Change from P1 to P2 (c)	**24.57%**	**8.54%**	**5.04%**	**-8.26%**	**-2.33%**	**457.69%**

Notes:
Period 1 (January 1994 to December 1999) and Period 2 (January 2000 and April 2024) represent the pre-financialisation period and post financialisation period, respectively. Period 2 is divided into three subperiods: Period 2 (a), Period 2 (b) and Period 2 (c). Period 2 (a) is from January 2000 to December 2011. Period 2 (b) is from January 2012 to December 2019. Period 2 (c) is from January 2020 to April 2024.
Source: Author’s own calculations

4.2.2. Cross-sector pairwise rolling return correlation of futures prices

Table 8 provides a sample of some of the results for the 12-month rolling return correlation of daily prices for pairs of commodity futures price across different sectors. The tabulated results for all 31 pairs of commodity futures across different sectors can be found in Appendix A, Tables A13-A15, and graphical illustrations of the results can be found in Appendix D.

Table 8: Cross-Sector Return Correlation for Pairs of Futures in the Precious Metal, Energy and Industrial Metal Sectors

	WTI vs Gold	WTI vs LME Cop	WTI vs Alum	WTI vs Zinc	Brent vs Alum	Brent vs LME Cop	Brent vs Plat	Gold vs Nickel
Period 1 (pre-financialisation)	0.075	0.024	-0.014	0.033	0.020	0.041	0.072	0.038
Period 2 (post-financialisation)	0.185	0.239	0.209	0.179	0.202	0.242	0.192	0.163
Period 2 - Period 1	0.110	0.215	0.223	0.146	0.182	0.201	0.121	0.125
% Change: P1 to P2	**146.36**	**886.82**	**1609.99**	**445.33**	**897.74**	**484.76**	**168.61**	**324.91**
Period 2 (a)	0.241	0.200	0.187	0.154	0.181	0.205	0.153	0.152
Period 2 (a) - Period 1	0.166	0.176	0.201	0.122	0.161	0.164	0.081	0.113
% Change: P1 to P2 (a)	**221.71**	**725.37**	**1448.14**	**370.56**	**795.41**	**396.13**	**113.39**	**295.12**
Period 2 (b)	0.143	0.278	0.223	0.202	0.205	0.260	0.230	0.179
Period 2 (b) - Period 1	0.068	0.253	0.237	0.169	0.184	0.219	0.158	0.140
% Change: P1 to P2 (b)	**90.52**	**1046.84**	**1710.39**	**516.22**	**910.20**	**528.33**	**221.08**	**364.75**
Period 2 (c)	0.105	0.276	0.246	0.204	0.255	0.311	0.232	0.167
Period 2 (c) - Period 1	0.030	0.252	0.260	0.171	0.235	0.269	0.161	0.128
% Change: P1 to P2 (c)	**40.03**	**1039.59**	**1874.77**	**522.05**	**1160.05**	**650.95**	**225.03**	**333.89**

Notes:
Period 1 (January 1994 to December 1999) and Period 2 (January 2000 and April 2024) represent the pre-financialisation period and post financialisation period, respectively. Period 2 is divided into three subperiods: Period 2 (a), Period 2 (b) and Period 2 (c). Period 2 (a) is from January 2000 to December 2011. Period 2 (b) is from January 2012 to December 2019. Period 2 (c) is from January 2020 to April 2024.
Source: Author's own calculations

For Period 2 (post-financialisation) the results are in line with expectations and are in line with what was found for pairs of futures in the same sector. Namely, the return correlation for pairs of cross-sector indexed commodity futures was low and close to zero in Period 1 (pre-financialisation) and increased substantially in Period 2 (post-financialisation). Of the 26 pairs of indexed commodity futures, 26 of the pairs (or 100%) showed increased return correlation in Period 2 (post-financialisation) versus Period 1 (pre-financialisation). Of the 26 pairs which showed increased return correlation in Period 2 (post-financialisation) versus Period 1 (pre-financialisation), all 26 of the pairs showed increased return correlation of more than 50%, and 19 of the pairs increased by more than 100%. Some of the largest increases in return correlation were between the returns of WTI crude oil and aluminium (+1609.99%), WTI crude oil and CMX copper (+1067%), WTI crude oil and LME copper (+886.82%), Brent crude oil and aluminium (+897.74%), Brent crude oil and zinc (331.94%), gold and nickel (+324.91%), Brent crude oil and platinum (+168.61%), and gold and WTI crude oil (+146.36%). For pairs with one of the commodities weighted in a major commodity index and the other, non-indexed (e.g. palladium and tin), the return correlation increased substantially for all pairs in Period 2 (post-financialisation). No examples of falling correlation were found. Return correlations rose substantially between WTI crude oil and palladium (+688.84%), WTI crude oil and tin (+1792.77%), Brent crude oil and palladium (+178.54%), Brent crude oil and tin (+1651.27%), and gold and tin (+113.52%).

For Period 2(a) (2000-2011), Period 2(b) (2012-2019) and Period 2(c) (2020-2024), the pairs of cross-sector indexed futures are substantially more highly correlated throughout these three post-financialisation sub-periods relative to Period 1 (pre-financialisation).

The expectation that futures pairs with one of the commodities weighted in a major commodity index and the other, non-indexed (i.e palladium and tin), would show little change in correlation in Period 2(a) (2000-2011), Period 2(b) (2012-2019) and Period 2(c) (2020-2024) was not met. Pairs such as WTI crude oil and palladium, WTI crude oil and tin, Brent crude oil and palladium, Brent crude oil and tin, and gold and tin, had higher return correlation in these periods compared to Period 1 (pre-financialisation).

4.2.3. Conclusion for futures prices

It appears that the return correlation for pairs of indexed futures prices in the same sector in Period 2(c) (2020-2024) are not quite as high relative to Period 1 (pre-financialisation), as what was found in Period 2(a) (2000-2011) and Period 2(b) (2012-2019). In some cases, such as the livestock and grains sectors, return correlation for pairs of spot prices has fallen below that of Period 1 (pre-financialisation), while the energy, precious metals, industrial metals and softs sectors remain higher.

What is important is that the change in the futures price pairwise return correlation structure between Period 1 (pre-financialisation) and Period 2 (post-financialisation) is evident throughout all post-financialisation sub-periods as well as when indexed futures commodities are tested in pairs from the same sector and across different sectors. The increase in return correlation for cross-sector pairs of indexed futures prices is particularly large and pronounced in Period 2 (post-financialisation) as there was very low cross-sector return correlation in Period 1 (pre-financialisation). Same-sector futures pairs already presented modest levels of return correlation in Period 1 (pre-financialisation), perhaps related to same sector fundamentals, and so the increase was comparatively less important.

4.2.4. Pairwise rolling return correlation of spot prices in the same sector

Financialisation occurs in the futures markets. Therefore, correlation between indexed commodities in the spot market will rise in line with increases in correlation in the futures market only if, as some commentators have claimed, there is a spillover between futures buying and spot prices. Table 9 provides a sample of some of the results for the 12-month rolling return correlation of pairs of commodity spot prices in the same sector. The tabulated results for all 24 pairs of commodity spot in the same sector can be found in Appendix A, Tables A9-A12, and graphical illustrations of the results can be found in Appendix C.

Table 9: Rolling return correlation results for pairs of commodity spot in the same sector

	Gold vs Silver	Silver vs Plat	Brent vs Heat Oil	LME Cop vs Zinc	LME Cop vs Alum	Zinc vs Alum	Nickel vs Zinc	LME Cop vs Lead
Period 1 (pre-financialisation)	0.394	0.483	0.512	0.415	0.476	0.413	0.430	0.360
Period 2 (post-financialisation)	0.436	0.505	0.548	0.658	0.633	0.568	0.504	0.534
Period 2 - Period 1	0.043	0.023	0.037	0.242	0.157	0.155	0.074	0.174
% Change: P1 to P2	**10.841**	**4.666**	**7.202**	**58.282**	**33.042**	**37.398**	**17.187**	**48.243**
Period 2 (a)	0.430	0.452	0.504	0.697	0.723	0.622	0.535	0.564
Period 2 (a) - Period 1	0.036	-0.031	-0.007	0.282	0.248	0.209	0.105	0.204
% Change: P1 to P2 (a)	**9.265**	**-6.374**	**-1.450**	**67.814**	**52.095**	**50.445**	**24.418**	**56.778**
Period 2 (b)	0.462	0.573	0.582	0.648	0.550	0.539	0.519	0.600
Period 2 (b) - Period 1	0.069	0.090	0.070	0.232	0.074	0.126	0.089	0.240
% Change: P1 to P2 (b)	**17.466**	**18.659**	**13.692**	**55.906**	**15.541**	**30.408**	**20.704**	**66.695**
Period 2 (c)	0.405	0.528	0.610	0.565	0.535	0.471	0.389	0.324
Period 2 (c) - Period 1	0.011	0.046	0.099	0.150	0.059	0.058	-0.041	-0.036
% Change: P1 to P2 (c)	**2.914**	**9.437**	**19.269**	**36.108**	**12.443**	**14.002**	**-9.526**	**-9.879**

Notes:
Period 1 (January 1994 to December 1999) and Period 2 (January 2000 and April 2024) represent the pre-financialisation period and post financialisation period, respectively. Period 2 is divided into three subperiods: Period 2 (a), Period 2 (b) and Period 2 (c). Period 2 (a) is from January 2000 to December 2011. Period 2 (b) is from January 2012 to December 2019. Period 2 (c) is from January 2020 to April 2024.
Source: Author's own calculations

4.2.4.1. Period 2 versus Period 1

The results for Period 2 (post-financialisation) support the claim that financialisation in the future markets spilled over into the spot market too. As was the case for pairs of futures prices in the same sector, it is evident across all three sectors that return correlation has increased in Period 2 (post-financialisation) relative to Period 1 (pre-financialisation). 16

out of 16 (or 100%) pairs of spot prices in the same sector which have indexed futures counterparts increased in return correlation in Period 2 (post-financialisation) versus Period 1 (pre-financialisation). Of the 16 pairs of commodity spot in which both commodities have futures counterparts indexed in major commodity indices and showed increases in correlation in Period 2 (post-financialisation) compared to Period 1 (pre-financialisation), 10 pairs increased by more than 10% and 6 pairs increased by more than 20%.

Some of the most significant increases in return correlation were between the returns of LME copper and lead (+48.24%), LME copper and zinc (+58.28%), LME copper and aluminium (+33.04%), lead and aluminium (+24.36%), zinc and aluminium (+37.40%), nickel and zinc (+17.19%) and LME copper and nickel (+17.88%).

It is expected that spot pairs where one commodity has a futures counterpart weighted in a major commodity index and the other has a non-indexed futures counterpart, may show little change in correlations in Period 2 (post-financialisation) compared to Period 1 (pre-financialisation). However, no examples were found which confirmed this expectation, and in some cases, the opposite was found and return correlations in fact rose. Examples include gold and palladium (+34.29%), silver and palladium (+31.49%), platinum and palladium (+9.66%), LME copper and tin (+33.56%), lead and tin (+6.16%), nickel and tin (+4.05%), zinc and tin (+15.18%), and aluminium and tin (+1.49%).

4.2.4.2. Period 2(a) versus Period 1

Results for period 2(a) (2000-2011) are mostly in line with expectations. Spot pairs where both commodities have futures counterparts weighted in major commodity indices mostly show increases in correlation in Period 2(a) (2000-2011) compared to Period 1 (pre-financialisation). The exceptions to this were gold and platinum (-8.87%), silver and platinum (-6.37%), and Brent crude oil and heating oil (-1.45%). 13 out of 16 (or 81%) pairs of spot prices in the same sector which have indexed futures counterparts increased in return correlation in Period 2 (post-financialisation) versus Period 1 (pre-financialisation). Of the 13 pairs of commodity spot in which both commodities have futures counterparts indexed in major commodity indices and showed increases in correlation in Period 2 (post-financialisation) compared to Period 1 (pre-financialisation), 11 pairs increased by more than 10% and 7 pairs increased by more than 20%.

Some of the largest increases were WTI crude oil and heating oil (+10.22%), LME copper and lead (+56.78%), LME copper and zinc (+67.81%), LME copper and aluminium (+52.10%), lead and aluminium (+35.81%), LME copper and nickel (+25.35%), zinc and aluminium (+50.45%), nickel and zinc (+24.42%), and lead and zinc (+17.95%).

As before, it is expected that spot pairs with one futures counterpart weighted in a major commodity index and the other, a non-indexed futures counterpart, may show little change in correlation in Period 2(a) (2000-2011) compared to Period 1 (pre-financialisation). No examples were found which confirmed this expectation, and in some cases, the opposite was found and return correlation in fact rose. Examples include gold and palladium (+29.55%), silver and palladium (+34.57%), platinum and palladium (+11.55%), LME copper and tin (+40.67%), lead and tin (+11.67%), nickel and tin (+7.07%), zinc and tin (+20.02%), and aluminium and tin (+12.33%).

4.2.4.3. Period 2(b) versus Period 1

Results for Period 2(b) (2012-2019) are in line with expectations. The results confirm the expectation that returns for pairs of spot prices with indexed futures counterparts are more highly correlated in Period 2(b) (2012-2019) relative to Period 1 (pre-financialisation). 16 out of 16 (or 100%) pairs of spot prices in the same sector which have indexed futures counterparts increased in return correlation in Period 2 (post-financialisation) versus Period 1 (pre-financialisation). Of the 16 pairs of commodity spot in which both commodities have futures counterparts indexed in major commodity indices and showed increases in correlation in Period 2 (post-financialisation) compared to Period 1 (pre-financialisation), 13 pairs increased by more than 10% and 8 pairs increased by more than 20%. Some of the most significant increases were gold and platinum (+30.41%), silver and platinum (+18.66%), gold and silver (+17.47%), Brent crude oil and heating oil (+13.69%), LME copper and lead (+66.70%), LME copper and zinc (+55.91%), lead and zinc (+34.65%), lead and aluminium (+31.87%), LME copper and nickel (+25.15%), LME copper and aluminium (+15.54%), nickel and zinc (+20.74%), and zinc and aluminium (+30.41%).

For spot pairs with one futures counterpart weighted in a major commodity index and the other, a non-indexed futures counterpart, one pair, aluminium and tin showed a fall in correlation (-8.01%), whereas, in the other cases return correlations rose. These include gold and palladium (+49.23%), silver and palladium (+20.84%), platinum and palladium (+11.33%), LME copper and tin (+22.68%), lead and tin (+8.39%), nickel and tin (+6.18%), and zinc and tin (+10.03%).

4.2.4.4. Period 2(c) versus Period 1

The results for Period 2(c) (2020-2024) show that some of the pairs of spot prices with indexed futures counterparts show higher return correlations in Period 2(c) (2020-2024 compared to Period 1 (pre-financialisation). 7 out of 16 (or 43%) pairs of spot prices in the same sector which have indexed futures counterparts increased in return correlation in Period 2 (post-financialisation) versus Period 1 (pre-financialisation). Of the 7 pairs of commodity spot in which both commodities have futures counterparts indexed in major commodity indices and showed increases in correlation in Period 2 (post-financialisation) compared to Period 1 (pre-financialisation), 4 pairs increased by more than 10% and 2 pairs increased by more than 20%.Examples of spot pairs with indexed futures counterparts that show falling correlation in Period 2(c) (2020-2024) compared to Period 1 (pre-financialisation) include gold and platinum (-4.90%), WTI crude oil and heating oil (-8.32%), LME copper and nickel (-16.51%), lead and nickel (-39.58%), aluminium and lead (-21.53%) and nickel and aluminium (-29.95%).

For spot pairs with one futures counterpart weighted in a major commodity index and the other, a non-indexed futures counterpart, falling correlations in Period 2(c) (2020-2024) compared to Period 1 (pre-financialisation) were found for aluminium and tin (-11.13%), nickel and tin (-8.32%), and lead and tin (-13.36%). Correlations rose for gold and palladium (+19.71%), silver and palladium (+25.96%), platinum and palladium (+1.32%), LME copper and tin (+33.96%), and zinc and tin (+11.28%).

4.2.4.5. Changes in return correlation of spot prices by sector

Table 10 shows the sector average return correlation for pairs of indexed commodity futures across the pre- and post-financialisation periods. Results for Table 8 were calculated using the rolling return correlation results in Tables A7-A10 in Appendix A.

Table 10: Sector Average Return Correlation for Pairs of Spot Commodities with Indexed Futures Counterparts

	Precious Metals	Energy	Industrial Metals
Period 1 (pre-financialisation)	0.427	0.577	0.426
Period 2 (post-financialisation)	0.454	0.620	0.536
% Change from P1 to P2	**6.32%**	**7.45%**	**25.82%**
Period 2 (a)	0.416	0.600	0.576
% Change from P1 to P2 (a)	**-2.58%**	**3.99%**	**35.21%**
Period 2 (b)	0.520	0.631	0.552
% Change from P1 to P2 (b)	**21.78%**	**9.36%**	**29.58%**
Period 2 (c)	0.439	0.658	0.393
% Change from P1 to P2 (c)	**2.81%**	**14.04%**	**-7.75%**

Notes:
Period 1 (January 1994 to December 1999) and Period 2 (January 2000 and April 2024) represent the pre-financialisation period and post financialisation period, respectively. Period 2 is divided into three subperiods: Period 2 (a), Period 2 (b) and Period 2 (c). Period 2 (a) is from January 2000 to December 2011. Period 2 (b) is from January 2012 to December 2019. Period 2 (c) is from January 2020 to April 2024.
Source: Author’s own calculations

According to the results in Table 10, all sectors show a higher relative level of return correlation for spot pairs in the same sector with indexed futures counterparts in Period 2 (post-financialisation) compared to Period 1 (pre-financialisation). The most significant increase in return correlation is in the industrial metals sector (+25.82%). Regarding Period 2(a) (2000-2011), all sectors, except for precious metals (-2.58%), show an increase in correlation compared to Period 1 (pre-financialisation). Regarding Period 2(b) (2012-2019), all sectors show higher return correlation compared to Period 1 (pre-financialisation). In Period 2(c) (2020-2024), return correlation has increased compared to Period 1 (pre-financialisation) for the precious metal (+2.81%) and energy (+14.04%) sectors. Compared to Period 2(a) (2000-2011) and Period 2(b) (2012-2019), the level of return correlation in Period 2(c) (2020-2024) for the precious metal and industrial metal sectors has decelerated, while the energy sector’s level of return correlation has accelerated. Meanwhile, the return correlation within the industrial metal sector (-7.75%) has fallen in Period 2 (c) (2020-2024) compared to Period 1 (pre-financialisation). A similar result was found for futures prices of the industrial metal sector in Period 2(c) (2020-2024), where although in the case of pairs of futures, the return correlation wasn't necessary lower than Period 1 (pre-financialisation), but it was a significantly lower level of return correlation compared to Period 2(a) (2000-2011) and Period 2(b) (2012-2019).

4.2.5. Cross-sector pairwise rolling return correlation of spot prices

Table 11 provides a sample of some of the results for the 12-month rolling return correlation of daily returns of pairs between spot prices for commodities in different sectors that have futures prices. The tabulated results for all 29 pairs of commodity spot prices across different sectors can be found in Appendix A, Tables A16-A18, and graphical illustrations of the results can be found in Appendix E.

For Period 2 (post-financialisation) the results are in line with expectations and are like what was found for spot pairs in the same sector. The return correlation for all cross-sector pairs of spot prices with indexed futures counterparts was low in Period 1 (pre-financialisation) and increased substantially in Period 2 (post-financialisation). 24 out of the 24 (or 100%) pairs of spot prices in the same sector in which both spot commodities have indexed futures counterparts increased in return correlation in Period 2 (post-financialisation) versus Period 1 (pre-financialisation). Of the 24 pairs of commodity spot which showed increases in return correlation in Period 2 (post-financialisation) compared to Period 1 (pre-financialisation), 23 of the pairs increased by more than 50%, and 22 increased by more than 100%. Some of the largest increases in return correlation were between the returns of Brent crude oil and aluminium (+9347.50%), WTI crude oil and aluminium (+1142.47%), Brent crude oil and platinum (+1942.01%), WTI crude oil and LME copper (+870.66%), WTI crude oil and zinc (+540.52%), gold and heating oil (+300.16%), gold and WTI crude oil (+273.26%), and silver and WTI crude oil (+266.29%). For spot pairs with one of the commodities weighted in a major commodity index and the other, non-indexed, no examples of falling correlation were found. In some cases, the correlation rose dramatically. Such cases include returns between WTI crude oil and palladium (+840.08%), WTI crude oil and tin (+1830.86), Brent crude oil and palladium (+145.72%), Brent crude oil and tin (+537.64%), and gold and tin (+91.14%).

Table 11: Cross-Sector Return Correlation for Spot Pairs in the Precious Metal, Energy and Industrial Metal Sectors

	WTI vs Gold	WTI vs LME Cop	WTI vs Alum	WTI vs Zinc	Brent vs Alum	Brent vs Plat	Gold vs LME Cop
Period 1 (pre-financialisation)	0.037	0.027	-0.022	0.031	0.002	0.009	0.121
Period 2 (post-financialisation)	0.139	0.258	0.230	0.197	0.221	0.179	0.246
Period 2 - Period 1	0.102	0.231	0.253	0.166	0.218	0.170	0.126
% Change: P1 to P2	**273.26**	**870.66**	**1142.47**	**540.52**	**9347.50**	**1942.01**	**104.31**
Period 2 (a)	0.157	0.228	0.212	0.188	0.200	0.190	0.255
Period 2 (a) - Period 1	0.12	0.20	0.23	0.16	0.197	0.181	0.135
% Change: P1 to P2 (a)	**321.09**	**757.21**	**1059.73**	**513.75**	**8445.02**	**2063.40**	**111.78**
Period 2 (b)	0.131	0.299	0.255	0.212	0.233	0.165	0.250
Period 2 (b) - Period 1	0.093	0.272	0.277	0.182	0.231	0.157	0.130
% Change: P1 to P2 (b)	**250.08**	**1024.88**	**1252.07**	**591.25**	**9896.66**	**1786.82**	**107.38**
Period 2 (c)	0.105	0.266	0.236	0.191	0.256	0.175	0.214
Period 2 (c) - Period 1	0.068	0.239	0.259	0.160	0.253	0.166	0.094
% Change: P1 to P2 (c)	**182.95**	**900.02**	**1169.41**	**520.83**	**10843.64**	**1892.04**	**77.78**

Notes:
Period 1 (January 1994 to December 1999) and Period 2 (January 2000 and April 2024) represent the pre-financialisation period and post financialisation period, respectively. Period 2 is divided into three subperiods: Period 2 (a), Period 2 (b) and Period 2 (c). Period 2 (a) is from January 2000 to December 2011. Period 2 (b) is from January 2012 to December 2019. Period 2 (c) is from January 2020 to April 2024.
Source: Author’s own calculations

Regarding Periods 2(a) (2000-2011), 2(b) (2012-2019) and 2(c) (2020-2024), the results demonstrate that cross-sector spot pairs with indexed futures counterparts are more highly correlated throughout these three post-financialisation periods compared to Period 1 (pre-financialisation). The expectation that spot pairs with one of the commodities futures counterparts weighted in a major commodity index and the other, non-indexed (i.e palladium and tin), would have little change in return correlations in Periods 2(a) (2000-2011), 2(b) (2012-2019) and 2(c) (2020-2024) was therefore not met. Pairs such as WTI crude oil and palladium, WTI crude oil and tin, Brent crude oil and palladium, Brent crude oil and tin, and gold and tin, had higher return correlation in these periods compared to Period 1 (pre-financialisation).

4.2.6. Conclusion for spot prices

The return correlations for pairs of spot prices in the same sector in Period 2(c) (2020-2024) are not quite as high relative to Period 1 (pre-financialisation), as what was found in Period 2(a) (2000-2011) and Period 2(b) (2012-2019). In some cases, such as the industrial metal sector, return correlation for pairs of spot prices has fallen below that of Period 1 (pre-financialisation), while the energy and precious metals sector remain higher. These results are therefore similar for the return correlation for pairs of indexed futures in the same sector. In that return correlation for pairs of spot prices in the same sector for Period 2(c) (2020-2024) remained significant compared to Period 1 (pre-financialisation), but on a relative basis, is less significant than what was found in Period 2(a) (2000-2011) and Period 2(b) (2012-2019) for sectors such as precious metals and industrial metals.

What is important is that the change in the spot price pairwise return correlation structure between Period 1 (pre-financialisation) and Period 2 (post-financialisation) is evident throughout all post-financialisation sub-periods, as well as when spot commodities are tested in pairs from the same sector and across different sectors. Similarly to what was found for cross-sector indexed futures, the increase in return correlation for cross-sector pairs of spot prices with indexed futures counterparts is particularly large and pronounced in Period 2 (post-financialisation) as there was very low and insignificant return correlation in Period 1 (pre-financialisation), whereas same-sector spot pairs did already present modest levels of return correlation in Period 1 (pre-financialisation), perhaps due to same sector fundamentals, and so the increase was comparatively less.

4.2.7. Cross-market and cross-asset rolling return correlation

As discussed in Chapter 2, a key explanation for the rapid growth of investor interest in commodity markets in the early 2000s was to secure the portfolio diversification benefits associated with investment into commodities after the widely publicized discovery finding that commodity market returns and equity market returns are negatively correlated (Greer 2000, Gorton and Rouwenhorst, 2004, and Erb and Campbell, 2006). However, Tang and

Xiong (2012) found that since 2004, the wave of commodity index investors which flowed into the commodity markets had led to substantial positive increase in the return correlation between commodity futures but also between commodity and equity markets. In other words, the original logic of investing commodities as a risk-reducing asset class no longer existed.

This section examines whether the positive correlation between commodity and equity markets has persisted after Tang and Xiong's (2012) findings. To best understand the change in the structure of cross-market and cross-asset return correlation pre- and post-commodity financialisation, the full sample period (1994-2024) is split into the same sub-periods as was used for the pairwise rolling return correlation analyses.

The S&P GSCI Index is used as a benchmark for commodity market returns. The S&P 500 is used as a benchmark for US equity market returns (Tang and Xiong, 2012). The set of global equity market indices is broadened in this analysis to include the Dow Jones Industrials Index, the MSCI World Index, the MSCI Emerging Markets Index and the MSCI South Africa Index. The MSCI World Index includes large and mid-capitalisation representations throughout 23 developed market economies, whereas the MSCI Emerging Markets Index includes large and mid-capitalisation representations throughout 24 emerging market economies. To try capture the return correlation between commodity market returns and equity investor sentiment and risk aversion, the US Dollar Index, traded on the International Continental Exchange, is also included, and so is a benchmark index for the US 10-year Government Bond.

Table 12 presents the results for the 12-month rolling return correlation between the S&P GSCI Index and various equity indices, the USD index, and the benchmark index for the US 10-year government bond. Graphical illustrations of the results can be found in Appendix F.

The results show a substantial change in the cross-market return correlation structure between commodities and equities from Period 1 (pre-financialisation) to Period 2 (post-financialisation). In Period 1 (pre-financialisation), the return correlation between the S&P GSCI and the US equity markets (S&P 500 & DJI) is negative, providing evidence of the diversification benefits offered at that time by including commodities as an asset class.

However, the correlation with emerging market equities (MSCI World, MSCI Emerging Markets & MSCI SA) is positive, which means the same diversification benefits were not present for emerging market investors.

In Period 2 (post-financialisation), the correlation between the S&P GSCI and equity markets becomes positive. Between Period 1 (pre-financialisation) and Period 2 (post-financialisation), the return correlation between the S&P GSCI and the S&P 500 changes from -0.031 to 0.220 (+802.08%), and between the S&P GSCI and the Dow Jones Industrial Average the return correlation rose from -0.023 to 0.204 (+984.60%). The correlations with the MSCI World, EM and SA indices, which were already positive in period 1, increase in Period 2.

Importantly, this post-financialisation structural change towards an increasingly positive cross-market return correlation found between the S&P GSCI and equity indices appears to be increasing. The positive correlation between the S&P GSCI and the S&P 599 increases from 0.119 in Period 2(a) (2000-2011) to 0.340 in Period 2(b) (2012-2019) and 0.281 in Period 2(c) (2020-2024). For the S&P GSCI and the DJI the increase across the same 3 periods if from 0.081 to 0.328 and 0.338. Likewise, for the MSCI World, EM and SA indices the positive correlation is greater in Periods 2(b) and 2(c) than in Period 2(a). The findings of Tang & Xiong (2012) that the relationship between commodity and equity markets is now positive has therefore strengthened in more recent years.

Table 12: Rolling return correlation results between the S&P GSCI Index and other asset class markets and investor sentiment indices before and after commodity financialisation

	GSCI vs MSCI World	GSCI vs MSCI EM	GSCI vs MSCI SA	GSCI vs S&P 500	GSCI vs DOW J IND	GSCI vs USD IND	GSCI vs US 10yr IND
Period 1 (pre-financialisation)	0.025	0.028	0.046	-0.031	-0.023	-0.023	-0.047
Period 2 (post-financialisation)	0.287	0.265	0.230	0.220	0.204	-0.203	-0.231
Period 2 - Period 1	0.262	0.237	0.184	0.252	0.227	-0.181	-0.184
% Change: P1 to P2	**1040.28**	**846.89**	**401.60**	**802.08**	**984.60**	**789.61**	**388.916**
Period 2 (a)	0.204	0.228	0.195	0.119	0.081	-0.224	-0.196
Period 2 (a) - Period 1	0.179	0.200	0.149	0.150	0.104	-0.202	-0.148
% Change: P1 to P2 (a)	**708.90**	**713.47**	**325.35**	**478.68**	**452.50**	**881.54**	**313.545**
Period 2 (b)	0.394	0.307	0.247	0.340	0.328	-0.204	-0.248
Period 2 (b) - Period 1	0.369	0.279	0.202	0.371	0.351	-0.181	-0.201
% Change: P1 to P2 (b)	**1462.70**	**995.48**	**438.80**	**1182.69**	**1523.26**	**792.92**	**425.271**
Period 2 (c)	0.322	0.292	0.296	0.281	0.315	-0.143	-0.299
Period 2 (c) - Period 1	0.297	0.264	0.250	0.313	0.338	-0.121	-0.251
% Change: P1 to P2 (c)	**1179.00**	**942.69**	**545.07**	**996.27**	**1467.04**	**527.01**	**531.554**

Notes:
Period 1 (January 1994 to December 1999) and Period 2 (January 2000 and April 2024) represent the pre-financialisation period and post financialisation period, respectively. Period 2 is divided into three subperiods: Period 2 (a), Period 2 (b) and Period 2 (c). Period 2 (a) is from January 2000 to December 2011. Period 2 (b) is from January 2012 to December 2019. Period 2 (c) is from January 2020 to April 2024.
Source: Author's own calculations

The correlation between the S&P GSCI and the proxies for investor sentiment, the US Dollar Index and the US 10 Year Bond Index, went from being slightly negative in Period 1 (pre-financialisation), to even more negative in Period 2 (post-financialisation). In Period 1 (pre-financialisation), the return correlation between the S&P GSCI and the US Dollar Index was -0.023, whereas in Period 2 (post-financialisation), the negative return correlation was -0.203 (+789.61%). Similarly, in Period 1 (pre-financialisation), the return correlation between the S&P GSCI and the US 10 Year Bond Index was -0.047, whereas in Period 2 (post-financialisation), the negative return correlation was -0.231 (+388.92%). The increasingly negative return correlations between the S&P GSCI and the US Dollar Index and the US 10 Year Bond Index persist throughout all the post-financialisation sub-periods. The negative relationship is unsurprising given the already identified now positive relationship between commodity and equity indices. When sentiment is negative, the USD Index and Bond Index rise, and equity (and now commodity) returns fall. Conversely, when sentiment is positive the USD and Bond Index fall, and equity (and commodity) returns rise.

4.2.8. Conclusion for cross-market and cross-asset analysis

The results of this analysis suggest that post-financialisation, commodities are now treated in a similar way to equities, in that when equity investors experience risk-aversion, both commodity prices and equities fall (Kang, Tang and Wang, 2023). The positive return correlation identified between commodity and equity markets returns in Period 2 (post-financialisation) is thus explainable by the increasingly negative return correlation between commodity market returns and the returns from investor sentiment indices (Kang, Tang and Wang, 2023). Commodities in the post-financialisation era now receive a similar 'equity-like' risk-on and risk-off treatment. Meaning, the well-known negative return correlation structure between equities and investor sentiment indices, is now also evident between commodities and these investor sentiment indices in Period 2 (post-financialisation).

It is therefore prudent for investors to potentially recalibrate existing strategies and take into consideration this structural change in return correlation between commodity and equity markets. The belief that commodities provide an asset class that is not correlated to other asset classes appears to be no longer valid.

4.2.9. Summary and Conclusions for Method 1

It is evident from the Method 1 results that the commodity financialisation process has not just impacted futures prices in isolation, but that spot prices have been affected as well. Both future and spot prices experienced a significant structural change in return correlation in Period 2 (post-financialisation) compared to Period 1 (pre-financialisation).

Pairs of futures prices in the same sector experienced a substantial increase in positive return correlation in Period 2 (post-financialisation) compared to Period 1 (pre-financialisation). Regarding the most recent period, Period 2(c) (2020-2024), pairwise return correlation is still significantly higher compared to Period 1 (pre-financialisation), but not quite as high as that in Period 2(a) (2000-2011) and Period 2(b) (2012-2019). The reason for this is not clear, although it is plausible to suggest that capital inflows into commodity markets in the early stages of financialisation had been primarily through index investment strategies, and in the latter stages of commodity financialisation investors and speculators have adopted more sophisticated and advanced commodity trading strategies (Kang, Tang and Wang, 2023). It was expected that there would be increased institutional buying of commodity futures and commodity indices during a price upswing such as in Period 2(c) (2020-2024). It is important to note that it is not possible to make concretely definitive claims about trends in commodity index buying over this period in the absence of the direct data on institutional commodity investment holdings that exists for previous periods.

Pairs of spot prices in the same sector also experienced a substantial positive increase in return correlation in Period 2 (post-financialisation) compared to Period 1 (pre-financialisation). Like the results found for pairs of futures prices in the same sector, the return correlation for spot pairs in the same sector remains significantly higher in Period 2(c) (2020-2024) compared to Period 1 (pre-financialisation), but not quite as high as what was found in Period 2(a) (2000-2011) and Period 2(b) (2012-2019).

Cross sector pairs of indexed futures prices and cross sector pairs of spot prices with indexed futures counterparts also experienced substantial increases in return correlation in Period 2 (post-financialisation) compared to Period 1 (pre-financialisation). Unlike pairs of futures prices in the same sector and pairs of spot prices in the same sector, which both presented modestly positive return correlation in Period 1 (pre-financialisation), cross-sector pairs of futures prices and cross-sector pairs of spot prices saw a comparatively much larger percentage increases in return correlation in Period 2 (post-financialisation) because the return correlation was mostly non-existent in Period 1 (pre-financialisation).

The fact that results are consistent for both cross-sector pairs of futures prices as well as cross-sector pairs of spot prices is significant because commodities in the same sector are more likely to move in a synchronised way due to sector-related fundamentals, whereas the same cannot necessarily be said for completely unrelated, cross-sector pairs. These findings support the financialisation hypothesis, because both cross-sector pairs of futures prices and cross-sector pairs of spot prices experienced a fundamental change in return correlation structure in Period 2 (post-financialisation) compared to Period 1 (pre-financialisation). Financialisation did not occur only in futures markets, spot markets too, experienced a fundamental change associated with commodity market financialisation.

Findings show clear evidence of a structural change in cross-market return correlation between commodity and equity markets in Period 2 (post-financialisation). The results show that return correlation between commodities and equities was practically zero in Period 1 (pre-financialisation), and in Period 2 (post-financialisation) returns become substantially positively correlated. This structural change in the correlation coefficient's sign is significant, because the results are consistent when different global equity market benchmark indices are used. Interestingly, the positive return correlation between commodities and equities became increasingly more positive in Period 2(b) (2012-2019) and Period 2(c) (2020-2024) compared to Period 2(a) (2000-2011).

In contrast, the cross-asset return correlation between commodity market returns and that of investor sentiment indices such as the US 10-year Bond Index and the US Dollar Index were slightly negative in Period 1 (pre-financialistion) and became progressively more negative throughout Period 2 (post-financialistion). The results suggest that commodities receive a similar risk-on and risk-off treatment as equities, meaning that when investors become more risk averse, both equities and commodities fall, while capital safe havens such as US 10-year bonds and the US Dollar rise.

4.3. Method 2: Multiple Regression Analysis

This section begins with presenting the descriptive statistics. A pairwise correlation matrix is used to test the strength of linear association amongst each regression equation's independent variables, and to test for the presence of multicollinearity. Stationarity test results are presented. Lastly, the results of the multiple regression analysis are discussed.

4.3.1. Descriptive Statistics

Table 13: Descriptive Statistics

Statistic/Variable	Aluminium Spot	Aluminium Futures	LME Cop Spot	LME Cop Futures	Gold Spot	Gold Futures
Mean	0.011	0.011	0.022	0.022	0.023	0.023
Median	0.000	0.000	0.000	0.000	0.000	0.000
Min	-8.255	-8.306	-10.476	-12.573	-10.162	-9.821
Max	6.395	9.134	11.726	11.920	7.382	8.890
Standard Deviation	1.312	1.307	1.554	1.537	0.979	1.008
Number of Obs.	7903	7903	7903	7903	7903	7903

Notes:
Source: Author's own calculations

Table 14: Descriptive Statistics

Statistic/Variable	Silver Spot	Silver Futures	WTI Crude Spot	WTI Crude Futures
Mean	0.022	0.021	0.031	0.030
Median	0.000	0.000	0.000	0.000
Min	-19.586	-19.546	-28.138	-28.221
Max	18.279	12.196	42.583	31.963
Standard Deviation	1.881	1.843	2.615	2.488
Number of Obs.	7903	7903	7901	7901

Notes:
Source: Author's own calculations

Table 15: Descriptive Statistics

Statistic/Variable	MSCI EM	S&P 500 Composite	US 10 Year Index	US Dollar Index
Mean	0.008	0.030	0.0008	0.001
Median	0.000	0.000	0.000	0.000
Min	-9.994	-12.765	-2.876	-3.065
Max	10.073	10.957	4.053	2.524
Standard Deviation	1.138	1.161	0.469	0.480
Number of Obs.	7903	7903	7903	7903

Notes:
Source: Author’s own calculations

A summary of the descriptive statistics has been presented in Table 13, Table 14 and Table 15.

Table 16: Pairwise Correlation Matrix – Aluminium Regression

	Aluminium Futures	MSCI EM	S&P 500	US 10 Year	USD Index
Aluminium Futures	1.000				
MSCI EM	0.253	1.000			
S&P 500	0.160	0.428	1.000		
US 10 Year	-0.111	-0.171	-0.221	1.000	
USD Index	-0.184	-0.170	-0.062	-0.110	1.000

Notes:
Source: Author’s own calculations

Table 17: Pairwise Correlation Matrix – LME Copper Regression

	LME Copper Futures	MSCI EM	S&P 500	US 10 Year	USD Index
LME Copper Futures	1.000				
MSCI EM	0.324	1.000			
S&P 500	0.212	0.428	1.000		
US 10 Year	-0.137	-0.171	-0.221	1.000	
USD Index	-0.210	-0.170	-0.062	-0.110	1.000

Notes:
Source: Author’s own calculations

Table 18: Pairwise Correlation Matrix – Gold Regression

	Gold Futures	MSCI EM	S&P 500	US 10 Year	USD Index
Gold Futures	1.000				
MSCI EM	0.133	1.000			
S&P 500	-0.010	0.428	1.000		
US 10 Year	0.122	-0.171	-0.221	1.000	
USD Index	-0.371	-0.170	-0.062	-0.110	1.000

Notes:
Source: Author's own calculations

Table 19: Pairwise Correlation Matrix – Silver Regression

	Silver Futures	MSCI EM	S&P 500	US 10 Year	USD Index
Silver Futures	1.000				
MSCI EM	0.245	1.000			
S&P 500	0.091	0.428	1.000		
US 10 Year	0.021	-0.171	-0.221	1.000	
USD Index	-0.341	-0.170	-0.062	-0.110	1.000

Notes:
Source: Author's own calculations

Table 20: Pairwise Correlation Matrix – WTI Crude Oil Regression

	WTI Crude Futures	MSCI EM	S&P 500	US 10 Year	USD Index
WTI Crude Futures	1.000				
MSCI EM	0.208	1.000			
S&P 500	0.182	0.428	1.000		
US 10 Year	-0.147	-0.171	-0.221	1.000	
USD Index	-0.132	-0.170	-0.062	-0.110	1.000

Notes:
Source: Author's own calculations

Table 16 – 20 present a pairwise correlation matrix for each regression equation's independent variables. The correlation coefficient is a linear measure of the strength of association between variables. Results in terms of the coefficients signs (+/-) are in line with the Method 1's cross-asset and cross-market findings from Section 4.2.5. Causation should not be inferred from these interpretations.

4.3.2. Tests for Stationarity

Table 21: Stationarity Tests Results

	Level			
Augmented Dickey-Fuller Test				
Variable	None	Intercept	Trend & Intercept	I (d)
Aluminium Spot	-89.283***	-89.284***	-89.279***	I(0)
Aluminium Futures	-88.818***	-88.818***	-88.813***	I(0)
LME Copper Spot	-92.363***	-92.376***	-92.370***	I(0)
LME Copper Futures	-92.642***	-92.655***	-92.649***	I(0)
Gold Spot	-89.035***	-89.077***∅	-89.083***	I(0)
Gold Futures	-89.523***	-89.563***∅	-89.568***	I(0)
Silver Spot	-93.878***	-93.885***	-93.879***	I(0)
Silver Futures	-90.732***	-90.739***	-90.733***	I(0)
WTI Crude Oil Spot	-92.747***	-92.751***	-92.745***	I(0)
WTI Crude Oil Futures	-67.013***	-67.017***	-67.014***	I(0)
MSCI Emerging Markets Index	-71.642***	-71.640***	-71.636***	I(0)
S&P 500 Composite	-97.069***	-97.134***∅	-97.128***	I(0)
US 10 Year Bond Index	-64.999***	-64.996***	-64.997***	I(0)
US Dollar Index	-89.664***	-89.659***	-89.661***	I(0)
Phillips-Perron Test				
Aluminium Spot	-89.302***	-89.306***	-89.301***	I(0)
Aluminium Futures	-88.841***	-88.842***	-88.837***	I(0)
LME Copper Spot	-92.302***	-92.313***	-92.307***	I(0)
LME Copper Futures	-92.586***	-92.595***	-92.589***	I(0)
Gold Spot	-89.035***	-89.078***∅	-89.084***	I(0)
Gold Futures	-89.529***	-89.574***∅	-89.580***	I(0)
Silver Spot	-93.889***	-93.912***	-93.906***	I(0)
Silver Futures	-90.727***	-90.741***	-90.735***	I(0)
WTI Crude Oil Spot	-92.940***	-92.950***	-92.945***	I(0)
WTI Crude Oil Futures	-89.959***	-89.960***	-89.955***	I(0)
MSCI Emerging Markets Index	-71.380***	-71.375***	-71.371***	I(0)
S&P 500 Composite	-97.256***	-97.626***∅	-97.620***	I(0)
US 10 Year Bond Index	-88.501***	-88.495***	-88.494***	I(0)
US Dollar Index	-89.668***	-89.663***	-89.665***	I(0)

Notes:
*** indicates p-value < 0.01; ** indicates p-value < 0.05; * indicates p-value < 0.10
∅ : Intercept is statistically significant (p-value of intercept is < 0.05)
♣ : Trend is statistically significant (p-value of trend is < 0.05)
Source: Author's own calculations

All variables were found to be stationary in level terms (integrated of order zero).

4.3.3. Multiple Regression Results

Table 22: Multiple Regression Analysis Results

Variable	WTI Crude Spot	Gold Spot	Silver Spot	LME Copper Spot	Aluminium Spot
WTI Crude Futures	0.862*** (0.023)				
Gold Futures		0.652*** (0.040)			
Silver Futures			0.136*** (0.045)		
LME Copper Futures				0.933*** (0.026)	
Aluminium Futures					0.947*** (0.016)
MSCI EM	0.008 (0.026)	0.050*** (0.008)	0.198*** (0.037)	0.056*** (0.015)	0.040*** (0.009)
S&P 500 Composite	-0.007 (0.035)	-0.034*** (0.012)	-0.097*** (0.034)	0.011 (0.011)	0.007 (0.006)
US 10 Year Bond Index	0.004 (0.021)	-0.002 (0.019)	-0.016* (0.042)	-0.015** (0.022)	-0.013** (0.015)
US Dollar Index	-0.006 (0.026)	-0.016* (0.020)	-0.014 (0.055)	-0.031*** (0.026)	-0.033*** (0.020)
FIN Dummy = 1 2000-2024, zero otherwise	-0.001 (0.005)	0.005 (0.007)	0.0004 (0.030)	0.001 (0.007)	-0.0001 (0.005)
Futures returns*FIN dummy	0.045*** (0.022)	0.113*** (0.045)	0.189*** (0.054)	-0.070** (0.032)	-0.072*** (0.022)
GFC Dummy = 1 2007-2008, zero otherwise	-0.001 (0.015)	-0.001 (0.008)	-0.003 (0.063)	-0.002 (0.016)	-0.002 (0.012)
Futures returns*GFC dummy	-0.020** (0.077)	0.044** (0.028)	-0.019 (0.087)	-0.001 (0.024)	-0.0002 (0.027)
CV19 Dummy = 1 2020-2021, zero otherwise	0.002 (0.009)	-0.0002 (0.009)	0.002 (0.053)	0.0003 (0.006)	0.0002 (0.008)
Futures returns*CV19 dummy	0.031** (0.034)	0.022 (0.049)	0.034* (0.062)	0.019*** (0.020)	0.027*** (0.017)
Constant	0.006 (0.005)	-0.004 (0.007)	0.016 (0.026)	-0.001 (0.007)	0.001 (0.004)
Observations	7901	7903	7903	7903	7903
R^2	0.832	0.639	0.168	0.821	0.825
F-stat	3550.687 [0.000]	1268.746 [0.000]	145.073 [0.000]	3283.69 [0.000]	3372.55 [0.000]
Wald_F-stat	2415.519 [0.000]	525.416 [0.000]	40.747 [0.000]	1781.11 [0.000]	2664.29 [0.000]
DW	2.372	2.855	2.617	2.572	2.538

Notes: *** indicates p-value < 0.01; ** indicates p-value < 0.05; * indicates p-value < 0.10
Parenthesis: Standard Error; Brackets: p-value of F-statistic and Wald F-statistic
Stanadardised (Scaled) Coefficients are reported, the Newey-West Estimator is used, and the

Lag Selection is AIC (Auto)
Source: Author's own calculations

4.3.3.1.WTI Crude Oil

WTI crude oil futures market returns are a statistically significant predictor of WTI crude oil spot market returns. Holding other predictor variables constant, a 1 percentage point increase in WTI crude oil futures returns, on average, results in a 0.86 percentage points increase in WTI crude oil spot returns.

MSCI EM returns, S&P 500 returns, US 10 year bond index returns and the US dollar index returns were insignificant predictors of WTI crude oil spot returns.

The interactive term 'Futures returns*FIN Dummy' implies that when the FIN dummy is one (i.e. financialisation period), WTI crude oil futures returns are multiplied by 1, and the coefficient of WTI crude oil futures market returns when the FIN dummy =1, is 0.045. This means that WTI crude oil spot market returns rise faster under conditions of financialisation, by 0.045 percentage points. Therefore, the overall slope coefficient becomes 0.862 + 0.045 = 0.907. The slope coefficient is larger in the financialisation period, and a structural change occurs in the relationship between WTI crude oil futures returns and WTI crude oil spot returns, with the marginal effect of WTI crude oil futures returns on WTI crude oil spot returns becoming heightened under conditions of financialisation. The causal effect of WTI crude oil futures returns on WTI crude oil spot returns in the financialisation period is strong and significant.

The interactive term 'Futures returns*GFC Dummy' implies that when the GFC (Global Financial Crisis period) dummy is 1 (one), WTI crude oil futures are multiplied by 1, and the coefficient of WTI crude oil futures market returns when the GFC dummy =1, is -0.020. This means that WTI crude oil spot market returns rise comparatively less under GFC conditions, by -0.020 percentage points. Therefore, the overall slope coefficient becomes 0.862 – 0.020 = 0.842. The slope coefficient is slightly less in the GFC period, meaning that the marginal effect of WTI crude oil futures returns on WTI crude oil spot returns is less under the conditions of the GFC. The causal effect of WTI crude oil futures returns on WTI crude oil spot returns in the Global Financial Crisis period is smaller since the interactive term coefficient is negative.

The interactive terms ‘Futures returns*CV19 Dummy’, implies that when the CV19 (Covid-19 period) dummy is 1 (one), WTI crude oil futures are multiplied by 1, and the coefficient of WTI crude oil futures market returns when the CV19 dummy=1, is 0.031. This implies that WTI crude oil spot market returns rise faster under conditions of Covid-19, by 0.031 percentage points. Therefore, the overall slope coefficient becomes 0.862 + 0.031 = 0.893. The slope coefficient is larger in the Covid-19 period, and a structural change occurs in the relationship between WTI crude oil futures returns and WTI crude oil spot returns, with the marginal effect of WTI crude oil futures returns on WTI crude oil spot returns becoming heightened under the conditions of Covid-19. The causal effect of WTI crude oil futures returns on WTI crude oil spot returns in the Covid-19 period is strong, although comparatively not as great as what was found in the overall financialisation period.

4.3.3.2. Gold

Gold futures market returns are a statistically significant predictor of gold spot market returns. Holding other predictor variables constant, a 1 percentage point increase in gold futures returns, on average, results in a 0.652 percentage points increase in gold spot returns.

MSCI EM returns, S&P 500 returns, US 10 year bond index returns and the US dollar index returns are insignificant predictors of gold spot returns.

The interactive term ‘Futures returns*FIN Dummy’ implies that when the FIN (financialisation period) dummy is 1 (one), gold futures returns are multiplied by 1, and the coefficient of gold futures market returns when the FIN dummy =1, is 0.113. This means that gold spot market returns rise faster under conditions of financialisation, by 0.113 percentage points. Therefore, the overall slope coefficient becomes 0.652 + 0.113 = 0.765. The slope coefficient is larger in the financialisation period, and a structural change occurs in the relationship between gold futures returns and gold spot returns, with the marginal effect of gold futures returns on gold spot returns becoming heightened under conditions of financialisation. The causal effect of gold futures returns on gold spot returns in the financialisation period is strong and significant.

The interactive term 'Futures returns*GFC Dummy' implies that when the GFC (Global Financial Crisis period) dummy is 1 (one), gold futures are multiplied by 1, and the coefficient of gold futures market returns when the GFC dummy =1, is 0.044. This means that gold spot market returns rise faster under GFC conditions, by 0.044 percentage points. Therefore, the overall slope coefficient becomes 0.652 + 0.044 = 0.696. The slope coefficient is larger in the GFC period, indicating a structural change occurs in the relationship between gold futures returns and gold spot returns, meaning that the marginal effect of gold futures returns on gold spot returns becomes heightened under the conditions of the GFC. The causal effect of gold futures returns on gold spot returns in the Global Financial Crisis period is statistically significant.

The causal effect of gold futures returns on gold spot returns in the Covid-19 period is insignificant compared to what was found in the overall financialisation period and the Global Financial Crisis period.

4.3.3.3. Silver

Silver futures market returns are a statistically significant predictor of silver spot market returns. Holding other predictor variables constant, a 1 percentage point increase in silver futures returns, on average, results in a 0.136% increase in silver spot returns.

A 1 percentage point increase in MSCI EM returns, on average, results in a 0.198 percentage points increase in silver spot returns, and this was found to be statistically significant. S&P 500 returns, US 10 year bond index returns and US dollar index returns were insignificant predictors of silver spot returns.

The interactive term 'Futures returns*FIN Dummy' implies that when the FIN (financialisation period) dummy is 1 (one), silver futures returns are multiplied by 1, and the coefficient of silver futures market returns when the FIN dummy =1, is 0.189. This means that silver spot market returns rise faster under conditions of financialisation, by 0.189 percentage points. Therefore, the overall slope coefficient becomes 0.136 + 0.189 = 0.325. The slope coefficient is larger in the financialisation period, and a structural change occurs in the relationship between silver futures returns and silver spot returns, with the marginal effect of silver futures returns on silver spot returns becoming heightened under conditions of financialisation. The causal effect of silver futures returns on silver spot returns in the financialisation period is strong and significant.

The interactive term ‘Futures returns*GFC Dummy’ implies that when the GFC (Global Financial Crisis period) dummy is 1 (one), silver futures are multiplied by 1, and the coefficient of silver futures market returns when the GFC dummy =1, is -0.019. This means that silver spot market returns are relatively less under GFC conditions, by -0.019 percentage points. Therefore, the overall slope coefficient becomes 0.136 - 0.019 = 0.117. The slope coefficient is less in the GFC period, meaning that the marginal effect of silver futures returns on silver spot returns becomes less significant under the conditions of the GFC. The causal effect of silver futures returns on silver spot returns in the Global Financial Crisis period is smaller since the interactive term coefficient is negative.

The interactive terms ‘Futures returns*CV19 Dummy’, implies that when the CV19 (Covid-19 period) dummy is 1 (one), silver futures are multiplied by 1, and the coefficient of silver futures market returns when the CV19 dummy=1, is 0.034. This implies that silver spot market returns rise faster under conditions of Covid-19, by 0.034 percentage points. Therefore, the overall slope coefficient becomes 0.136 + 0.034 = 0.170. The slope coefficient is larger in the Covid-19 period, and a structural change occurs in the relationship between silver futures returns and silver spot returns, with the marginal effect of silver futures returns on silver spot returns becoming heightened under the conditions of Covid-19. The causal effect of silver futures returns on silver spot returns in the Covid-19 period is strong, although comparatively not as large as what was found in the overall financialisation period.

4.3.3.4. LME Copper

LME copper futures market returns are a statistically significant predictor of LME copper spot market returns. Holding other predictor variables constant, a 1 percentage point increase in LME copper futures returns, on average, results in a 0.933 percentage points increase in LME copper spot returns.

MSCI EM returns, S&P 500 returns, US 10 year bond index returns and US dollar index returns are not significant predictors of LME copper spot returns.

The interactive term ‘Futures returns*FIN Dummy’ implies that when the FIN (financialisation period) dummy is 1 (one), LME copper futures returns are multiplied by 1, and the coefficient of LME copper futures market returns when the FIN dummy =1, is -0.070. This means that LME copper spot market returns rise slightly less under conditions of financialisation, by -0.070 percentage points. Therefore, the overall slope coefficient becomes 0.933 - 0.070 = 0.863. The slope coefficient is smaller in the financialisation period, and a structural change occurs in the relationship between LME copper futures returns and LME copper spot returns, with the marginal effect of LME copper futures returns on LME copper spot returns becoming less under conditions of financialisation. The causal effect of LME copper futures returns on LME copper spot returns in the financialisation period is smaller since the interactive term coefficient is negative, yet it was found to be statistically significant.

The causal effect of LME copper futures returns on LME copper spot returns in the Global Financial Crisis period and Covid-19 period is insignificant.

4.3.3.5. Aluminium

Aluminium futures market returns are a statistically significant predictor of aluminium spot market returns. Holding other predictor variables constant, a 1 percentage point increase in aluminium futures returns, on average, results in a 0.947 percentage points increase in aluminium spot returns.

MSCI EM returns, S&P 500 returns, US 10 year bond index returns and US dollar index returnsare are not significant predictors of aluminium spot returns.

The interactive term ‘Futures returns*FIN Dummy’ implies that when the FIN (financialisation period) dummy is 1 (one), aluminium futures returns are multiplied by 1, and the coefficient of aluminium futures market returns when the FIN dummy =1, is -0.072. This means that aluminium spot market returns rise slightly less under conditions of financialisation, by -0.070 percentage points. Therefore, the overall slope coefficient becomes 0.947 - 0.072 = 0.875. The slope coefficient is smaller in the financialisation period, and a structural change occurs in the relationship between aluminium futures returns and aluminium spot returns, with the marginal effect of aluminium futures returns on LME copper spot returns becoming less under conditions of financialisation. The causal effect of aluminium futures returns on aluminium spot returns in the financialisation period is smaller since the interactive term coefficient is negative, yet it was found to be statistically significant.

The causal effect of aluminium futures returns on aluminium spot returns in the Global Financial Crisis period and Covid-19 period is insignificant.

4.3.4. Summary and Conclusions from Method 2

In all five examples, futures market returns were found to be statistically significant predictors of spot market returns. WTI crude oil, gold, LME copper and aluminium had particularly large coefficients.

The causal effect of futures market returns on spot market returns under financialisation (2000-2024) was found to be statistically significant in all five examples. The causal effect in this period is particularly strong in the case of WTI crude oil, gold and silver, whereas the causal effect is smaller for LME copper and aluminium, as the interactive term coefficients were negative.

The causal effect of futures market returns on spot market returns under the Global Financial Crisis (2007-2008) period was found to be statistically significant in the case of WTI crude oil and gold. The causal effect is strong in the case of gold, as it was the only example with a positive interactive term coefficient.

The causal effect of futures market returns on spot market returns under the Covid-19 (2020-2021) period was found to be statistically significant in the case of WTI crude oil and silver. Interestingly, all five examples had positive interactive term coefficients.

4.4. Conclusion

Chapter 4 presented and discussed the empirical findings of the study using the Method 1 and Method 2 procedures which were outlined in Chapter 3.

The rolling correlation method findings confirm that the financialisation effect and the associated structural changes to pairwise return correlation did not only impact futures markets, but spot markets too. This was evident in the results of same sector and cross sector analyses for pairs of commodity spot and futures prices. In addition to this, the structural changes to both cross-market return correlation between commodities and equities, and cross-asset return correlation between commodities and investor sentiment indices further support the financialisation hypothesis.

The rolling correlation method findings for the most recent period, Period 2(c) (2020-2024), suggest that perhaps commodity index buying is becoming of reduced importance, because although the pairwise return correlation in this period is still elevated compared to Period 1 (pre-financialisation), it is more subdued compared to earlier periods in the financialisation era such as Period 2(a) (2000-2011) and Period 2(b) (2012-2019). Institutional investors may be employing more advanced trading strategies in commodity markets. It is difficult to make concrete conclusions about changes in index buying as the data which tracks actual total commodity assets under institutional management is no longer published and accessible.

The multiple regression findings showed that in the case of WTI crude oil, gold, silver, LME copper and aluminium, futures market returns were statistically significant predictors of spot market returns. These findings are important, given that the relationship between commodity spot markets and futures markets is a highly contested issue within the empirical debate on financialisation. Furthermore, the causal effect of futures market returns on spot market returns under financialisation (2000-2024) was found to be statistically significant in all five examples.

It is important to be cautious of potential endogeneity issues and how they may affect the results of this multiple regression analysis. Omitted variable bias may impact the results of the multiple regression analysis when a relevant variable that is highly correlated with both the dependent and one or more of the independent variables is left out of the model. Such a variable being omitted from the model may result in the effect of the omitted variable being falsely attributed to one or more of the included independent variables, leading to a distortion of estimates of the relationships which exist between the variables. Simultaneity occurs when a two-way causal relationship between the dependent and one or more of the independent variables in a regression model, and so the dependent variable may influence one or more of the independent variables, and those independent variables also influence the dependent variable. The estimated coefficients in a multiple regression model may become biased in the presence of simultaneity. Reverse causality occurs when the dependent variable influences the independent variable, rather than the independent variable affecting the dependent variable, as assumed in a regression model. Results may be inconsistent in the presence of reverse causality.

CHAPTER 5:
CONCLUSION AND POLICY RECOMMENDATIONS

5.1. Introduction

Commodity markets have experienced rapid growth in the last three decades. The historic volatility and growth in overall trading volumes during the 2000-2011 commodity super cycle was the catalyst for a debate around the drivers of the price developments throughout that period. The empirical literature is split into two camps, the first claims that non-fundamentals, such as the financialisation of commodity markets, drove the volatility throughout the 2000-2011 period (Masters, 2008, Tang and Xiong, 2012 and Mayer, 2012), whereas the second camp insists that the increases in prices were the result of structural changes to fundamental demand and supply drivers, and changes in the macroeconomic landscape (Stoll and Whaley, 2010, Irwin and Sanders, 2011 and Dwyer *et al*, 2011).

The aim of this study was to contribute to this debate in the following ways. Firstly, to contribute to the literature by expanding the period under investigation to include the 2020-2024 period of rising commodity prices. Secondly, to expand the range of commodities investigated. Thirdly, to examine the cross-market and cross-asset return correlation structure throughout the whole post financialisation period, and fourthly, to establish whether futures market returns are statistically significant predictors of spot market returns.

Chapter 2 introduced the theory and structure of commodity markets, the phenomenon of commodity market financialisation and provided a review of some of the key empirical literature investigating the impact of this financialisation. Chapter 3 described the data, data sources and the methodological techniques used in this study. Chapter 4 used 2 methods to investigate the impact of financialization. Method 1, measured changes in rolling return correlations pre- and post-financialisation. Method 2, used a multiple regression analysis to investigate whether changes in future market returns impacted spot market returns.

5.2. Key Findings

The key findings which can be identified from this study are:

- The most recent period of rising prices, Period 2(c) (2020-2024), was expected to show substantial increases in return correlation, comparable to Period 2(a) (2000-2011) when commodity prices rose sharply, as commodity prices have again shown a strong upward momentum since the 2020 Covid-19 market lows. However, this expectation was not fully met. While return correlations were higher than in the pre-financialisation period they were not as high as in Period 2(a). A possible reason for this is that index buying now appears to be of less importance. Evidence of this is that while the pairwise return correlation has remained elevated compared to Period 1 (pre-financialisation) it was slightly smaller compared to earlier periods of financialisation such as Period 2(a) (2000-2011) and Period 2(b) (2012-2019). It is important to note that it is not possible to make definitive claims about trends in commodity index buying in the absence for the most recent period of direct data on institutional commodity investment holdings.

- The study found that in Period 2 (post-financialisation), the pairwise return correlation of same sector and cross sector pairs of futures and spot prices is substantially more positive compared to Period 1 (pre-financialisation). The financialisation effect was therefore found to have impacted both commodity futures markets and spot markets. This structural change in return correlation between the two periods is especially pronounced for the cross sector pairwise return correlation analysis of pairs of spot and futures prices. Since the pairs of spot and futures prices in the *same sector* presented a modest level of return correlation in Period 1 (pre-financialisation), whereas unrelated, and *cross sector* pairs of futures prices and pairs of spot prices had comparatively much lower levels of return correlation in Period 1 (pre-financialisation), the percentage increases in return correlation throughout Period 2 (post-financialisation) are most pronounced in the cross sector pairs of futures and spot prices.

- The evidence of modest return correlation levels amongst pairs of spot and futures prices in the same sector in Period 1 (pre-financialisation) may be attributed to same sector fundamentals. The lack of return correlation amongst pairs of unrelated, cross sector futures and spot prices in Period 1 (pre-financialisation), may be attributed to a lack of similar fundamentals, as the commodities are in unrelated sectors. In contrast, the structural rise in return correlations for both cross sector pairs of futures and spot prices in Period 2 (post-financialisation) supports the financialisation hypothesis.

- The study extended previous findings which had examined the effect of financialisation on food and oil commodities (Tang and Xiong, 2012), and industrial metals and oil (Mann and Keeton, 2013, Ndawona *et al*, 2019), by including commodities from the softs, grains, livestock and precious metal sectors. The study found that all four additional sectors were impacted by financialisation, as pairwise return correlations were notably higher in Period 2 (post-financialisaiton) compared to Period 1 (pre-financialisation).

- The study also included indexed and non-indexed commodities (palladium, tin, orange juice and oats), on the assumption that when employing the pairwise rolling return correlation technique, it was expected that because of commodity market financialisation, the return correlation between indexed futures in the same sector in Period 2 (post-financialisation) will rise as index investors simultaneously buy futures of both commodities. Alternatively, when one commodity is indexed and the other commodity in the same sector is not indexed, there is no reason to believe that the return correlation will change as only the indexed future is bought. Only oats met this expectation, whereas palladium, tin and orange juice did not meet the expectation.

- The financialisation hypothesis is supported by the findings from the cross market and cross asset return correlation analysis. The structural change in cross market return correlation between commodity and equity markets from Period 1 (pre-financialisation) to Period 2 (post-financialisation) is a phenomenon which Tang and Xioing (2012) termed 'the financialisation of commodity markets'. This phenomenon has persisted and become more pronounced in more recent times, such as Period 2(b) (2012-2019) and Period 2(c) (2020-2024). A structural change in cross-asset return correlation is also evident, as commodity market returns and returns of investor sentiment indices were only slightly negatively correlated in

Period 1 (pre-financialisation) and that relationship has become progressively more negative throughout Period 2 (post-financialisation).

- The study found that futures market returns were statistically significant predictors of spot market returns. These findings are important, because the relationship between commodity spot markets and futures markets is a highly contested empirical issue within the debate on commodity financialisation. Furthermore, the study found evidence that the causal effect of futures market returns on spot market returns under financialisation (2000-2024) was statistically significant in all five examples studied (WTI crude oil, gold, silver, LME copper, aluminium).

- It is important to acknowledge some potential limitations of the study. Firstly, the study tested for causation using Method 2, the multiple regression analysis, in only a small sample of commodities. Secondly, recent data on institutional commodity investment holdings is no longer available, so it is not possible to definitively say what strategies or exposure institutions have in commodity markets in the more recent years. Thirdly, it is important to be cautious of potential endogeneity issues and how they may affect the results of this multiple regression analysis, namely, omitted variable bias, simultaneity and reverse causality.

5.3. Policy implications

5.3.1. Implications for investors

The finding of a positive correlation post-financialisation between commodity returns and equity market returns has important implications for investors. The motive for investing in commodities was supposed to be because commodity and equity markets were not correlated and, hence, investing in commodities provided portfolio diversity benefits. Such diversification benefits no longer exist, and it is therefore prudent for investors to recalibrate existing strategies and take into consideration this structural change in return correlation between commodity and equity markets. This is an important consideration for investors, as it was previously understood that commodity markets offer investors some portfolio protection against downside in equity markets.

5.3.2. Implications for policy makers

Effort should be made to compel all commodity derivative trading to occur in open regulated exchanges. This is not a new recommendation, as for some time regulators have been calling for all OTC commodity derivative trading be moved onto regulated exchanges and regulated digital trading platforms. The US and Europe have differing approaches to this issue. The US's Dodd-Frank Act only requires swap dealers to be fully registered, and Wall Street opposes such measures, instead favouring the 'clearing house' approach (Mathews, 2012). In contrast, the EU's Markets in Financial Derivatives (MiFiD), introduced in 2007, requires all futures trading to be facilitated either on traditional regulated exchanges, regulated multilateral trading facilities or organized trading facilities (Grant, 2010). All these facilities require full pre- and post-trading clarity, market scrutiny and requires impartial exchange operators to furnish non-discretionary executions of transactions (European Commission, 2011). The EU approach is supported because through mandating the use of regulated commodity trading exchanges it ensures that all trading has a clear administrative paper trail.

Secondly, position limits are necessary so that large institutional speculators do not distort and take excessively powerful positions in a market, which is normally done by cornering the supply side of commodity futures markets by establishing sizeable, short or long position. It is important that this should not happen as the finding in this research that futures prices impact spot prices means that such speculators will also be exerting influence spot market prices (Ghosh, 2011), which has important market stability and welfare implications (for example increasing the spot price of foodstuffs). However, it is important that traditional commercial hedgers, for example a large agricultural producer, be exempt from such position limits, because in theory, a traditional hedger cannot speculate (Ghosh, 2011). Position limits would make it certain that physical hedgers, instead of institutional actors interested in speculating, could corner and dominate certain commodity markets.

5.3.3. Implications for future Research

While this thesis has found evidence that the financialisation of commodity markets has impacted both futures and spot market price returns, it is not clear and conclusive in the empirical literature as to how this spillover between these two markets actually occurs. It is therefore imperative that further research investigate the practical relationship between futures and spot market transactions so that policy makers and regulators better understand the practical links between these markets and their decisions are better informed.

Specifically, future research should focus on how the transmission of information between futures and spot markets occurs, and also how this matters for consumers, and future studies should investigate the welfare implications associated with this. Lastly, future research is required which designs a framework outlining some form of a global regulatory cooperation to ensure commodity market regulation and stability and address cross-border issues in a highly interconnected digital market. Regulators need to have a way to effectively address the growing influence of algorithmic trading and high-frequency trading. A gap in the literature which deserves attention is what role environmental, social and governance (ESG) factors should play in regulating commodity market trading, especially in light of the rise of sustainable and green commodities.

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APPENDICES

Appendix A: Tabulated results of the rolling return correlation analysis

Table A1: Rolling return correlation results for pairs of precious metal **futures** prices

	Gold vs Silver	Gold vs Palladium	Gold vs Platinum	Silver vs Palladium	Silver vs Platinum	Platinum vs Palladium
Period 1 (pre-financialisation)	0.615	0.279	0.501	0.264	0.459	0.395
Period 2 (post-financialisation)	0.769	0.356	0.483	0.414	0.497	0.500
% change P1-P2	25.168	27.845	-3.649	56.790	8.385	26.418
Period 2 (a)	0.728	0.333	0.335	0.383	0.331	0.424
% change P1-P2(a)	18.548	19.552	-33.096	45.305	-27.817	7.189
Period 2 (b)	0.821	0.383	0.670	0.445	0.676	0.579
% change P1-P2(b)	33.593	37.463	33.600	68.811	47.365	46.565
Period 2 (c)	0.786	0.371	0.548	0.439	0.628	0.564
% change P1-P2(c)	27.963	33.090	9.215	66.474	36.869	42.587

Table A2: Rolling return correlation results for pairs of energy **futures** prices

	WTI vs Brent	WTI vs Gas Oil	WTI vs Nat Gas	WTI vs Heating Oil	Brent vs Gas Oil	Brent vs Nat Gas	Brent vs Heating Oil	Gas Oil vs Nat Gas	Gas Oil vs Heating Oil	Nat Gas vs Heating Oil
Period 1 (pre-financialisation)	0.759	0.427	0.107	0.729	0.512	0.101	0.710	0.077	0.509	0.173
Period 2 (post-financialisation)	0.852	0.547	0.193	0.778	0.615	0.186	0.814	0.130	0.633	0.229
% change P1-P2	12.249	27.905	79.694	6.663	20.105	84.362	14.714	67.377	24.440	32.537
Period 2 (a)	0.850	0.531	0.299	0.808	0.585	0.284	0.794	0.195	0.591	0.340
% change P1-P2(a)	11.999	24.272	178.712	10.793	14.188	181.903	11.896	151.231	16.170	96.936
Period 2 (b)	0.864	0.590	0.108	0.789	0.669	0.087	0.864	0.053	0.671	0.113
% change P1-P2(b)	13.831	38.090	1.114	8.165	30.471	-13.397	21.704	-31.587	31.961	-34.802
Period 2 (c)	0.835	0.509	0.053	0.674	0.601	0.095	0.778	0.091	0.679	0.135
% change P1-P2(c)	10.004	19.099	-50.369	-7.649	17.328	-5.910	9.575	17.533	33.521	-21.862

Table A3: Rolling return correlation results for pairs of industrial metal **futures** prices

	CMX Cop vs LME Cop	CMX Cop vs Lead	CMX Cop vs Nickel	CMX Cop vs Zinc	CMX Cop vs Alum	CMX Cop vs Tin	LME Cop vs Lead	LME Cop vs Nickel	LME Cop vs Zinc	LME Cop vs Alum
Period 1 (pre-financialisation)	0.671	0.252	0.350	0.289	0.391	0.243	0.352	0.464	0.408	0.489
Period 2 (post-financialisation)	0.792	0.419	0.453	0.532	0.507	0.347	0.536	0.546	0.621	0.615
% change P1-P2	18.087	66.436	29.270	84.482	29.788	42.745	52.261	17.675	52.131	25.742
Period 2 (a)	0.733	0.399	0.452	0.524	0.543	0.341	0.574	0.586	0.629	0.700
% change P1-P2(a)	9.206	58.362	28.999	81.615	39.056	39.968	63.156	26.310	54.168	43.089
Period 2 (b)	0.841	0.501	0.498	0.548	0.464	0.341	0.583	0.572	0.638	0.532
% change P1-P2(b)	25.362	98.963	42.213	90.005	18.887	40.288	65.722	23.349	56.218	8.722
Period 2 (c)	0.868	0.323	0.371	0.526	0.485	0.377	0.341	0.385	0.567	0.534
% change P1-P2(c)	29.329	28.457	5.951	82.206	24.213	55.062	-3.172	-16.967	38.847	9.005

Table A4: Rolling return correlation results for pairs of industrial metal **futures** prices

	LME Cop vs Tin	Lead vs Nickel	Lead vs Zinc	Lead vs Alum	Lead vs Tin	Nickel vs Zinc	Nickel vs Alum	Nickel vs Tin	Zinc vs Alum	Zinc vs Tin	Alum vs Tin
Period 1 (pre-financialisation)	0.293	0.411	0.504	0.370	0.341	0.427	0.434	0.381	0.439	0.331	0.339
Period 2 (post-financialisation)	0.438	0.419	0.552	0.436	0.360	0.479	0.445	0.394	0.522	0.369	0.344
% change P1-P2	49.184	1.817	9.455	17.860	5.407	12.215	2.675	3.460	18.873	11.302	1.487
Period 2 (a)	0.464	0.455	0.533	0.472	0.384	0.491	0.489	0.419	0.546	0.369	0.380
% change P1-P2(a)	58.270	10.659	5.778	27.530	12.632	14.830	12.767	9.800	24.385	11.385	12.056
Period 2 (b)	0.403	0.450	0.639	0.456	0.361	0.512	0.451	0.392	0.515	0.365	0.310
% change P1-P2(b)	37.339	9.297	26.779	23.096	5.931	19.807	3.845	2.764	17.257	10.154	-8.437
Period 2 (c)	0.428	0.260	0.441	0.300	0.287	0.388	0.314	0.332	0.468	0.375	0.307
% change P1-P2(c)	45.870	-36.763	-12.513	-18.857	-15.722	-9.202	-27.653	-12.932	6.503	13.207	-9.535

Table A5: Rolling return correlation results for pairs of livestock **futures** prices

	Live Cattle vs Feeder Cattle	Live Cattle vs Lean Hogs	Lean Hogs vs Feeder Cattle
Period 1 (pre-financialisation)	0.455	0.051	0.147
Period 2 (post-financialisation)	0.458	0.107	0.098
% change P1-P2	0.520	109.198	-32.986
Period 2 (a)	0.441	0.140	0.119
% change P1-P2(a)	-3.037	174.018	-18.842
Period 2 (b)	0.503	0.069	0.067
% change P1-P2(b)	10.530	36.214	-54.541
Period 2 (c)	0.418	0.084	0.099
% change P1-P2(c)	-8.172	64.126	-32.351

Table A6: Rolling return correlation results for pairs of grain **futures** prices

	Corn vs Soyb	Corn vs CWF	Corn vs KWF	Corn vs Oats	Corn vs Soy Oil	Corn vs Soy Meal	Soyb vs CWF	Soyb vs KWF	Soyb vs Oats	Soyb vs Soy Oil	Soyb vs Soy Meal
Period 1 (pre-financialisation)	0.522	0.460	0.445	0.580	0.344	0.500	0.301	0.284	0.472	0.595	0.825
Period 2 (post-financialisation)	0.557	0.590	0.554	0.403	0.418	0.468	0.387	0.377	0.321	0.630	0.806
% change P1-P2	6.671	28.438	24.304	-30.504	21.412	-6.328	28.741	32.836	-32.107	5.853	-2.334
Period 2 (a)	0.571	0.608	0.540	0.465	0.504	0.488	0.414	0.394	0.380	0.721	0.824
% change P1-P2(a)	9.441	32.158	21.273	-19.751	46.292	-2.445	37.441	38.852	-19.546	14.561	-0.051
Period 2 (b)	0.547	0.623	0.517	0.366	0.336	0.482	0.364	0.347	0.265	0.525	0.836
% change P1-P2(b)	4.853	35.475	16.090	-36.952	-2.506	-3.544	21.085	22.217	-43.994	-11.726	1.370
Period 2 (c)	0.534	0.483	0.517	0.299	0.332	0.388	0.357	0.385	0.260	0.568	0.696
% change P1-P2(c)	2.326	4.970	16.051	-48.505	-3.505	-22.341	18.708	35.804	-45.039	-4.446	-15.590

Table A7: Rolling return correlation results for pairs of grain **futures** prices

	CWF vs KWF	CWF vs Oats	CWF vs Soy Oil	CWF vs Soy Meal	KWF vs Oats	KWF vs Soy Oil	KWF vs Soy Meal	Oats vs Soy Oil	Oats vs Soy Meal	Soy Oil vs Soy Meal
Period 1 (pre-financialisation)	0.773	0.378	0.233	0.271	0.374	0.251	0.272	0.325	0.455	0.353
Period 2 (post-financialisation)	0.877	0.335	0.324	0.325	0.334	0.318	0.322	0.265	0.281	0.322
% change P1-P2	13.468	-11.577	39.490	19.838	-10.668	26.808	18.452	-18.385	-38.194	-8.635
Period 2 (a)	0.856	0.358	0.406	0.347	0.360	0.382	0.350	0.357	0.344	0.459
% change P1-P2(a)	10.808	-5.365	74.767	27.700	-3.715	52.346	28.749	9.852	-24.380	30.207
Period 2 (b)	0.908	0.345	0.244	0.332	0.331	0.241	0.312	0.163	0.247	0.238
% change P1-P2(b)	17.439	-8.960	4.783	22.435	-11.515	-4.004	14.734	-50.037	-45.612	-32.402
Period 2 (c)	0.877	0.251	0.246	0.253	0.267	0.283	0.263	0.201	0.169	0.096
% change P1-P2(c)	13.505	-33.773	5.639	-6.928	-28.490	12.877	-3.355	-38.282	-62.928	-72.784

Table A8: Rolling return correlation results for pairs of softs **futures** prices

	Coffee vs Cotton	Coffee vs Sugar	Coffee vs Cocoa	Coffee vs Orange Juice	Cotton vs Sugar	Cotton vs Cocoa	Cotton vs Orange Juice	Sugar vs Cocoa	Sugar vs Orange Juice	Cocoa vs Orange Juice
Period 1 (pre-financialisation)	-0.072	0.013	0.067	0.036	0.021	0.026	0.023	0.103	0.013	0.034
Period 2 (post-financialisation)	0.140	0.216	0.162	0.074	0.146	0.091	0.064	0.100	0.053	0.021
% change P1-P2	-294.178	1521.714	143.329	102.988	609.555	242.699	178.788	-2.413	291.357	-39.782
Period 2 (a)	0.158	0.183	0.186	0.083	0.145	0.112	0.066	0.109	0.041	0.041
% change P1-P2(a)	-318.992	1279.012	179.194	128.471	602.949	322.406	183.682	5.713	207.384	20.635
Period 2 (b)	0.115	0.275	0.138	0.042	0.112	0.070	0.064	0.080	0.037	0.020
% change P1-P2(b)	-259.875	1964.442	106.516	15.284	444.435	163.857	177.735	-22.473	176.824	-40.971
Period 2 (c)	0.136	0.196	0.141	0.107	0.213	0.071	0.062	0.115	0.113	-0.036
% change P1-P2(c)	-288.764	1375.267	111.750	195.033	935.122	166.997	167.095	12.229	738.651	-206.115

Table A9: Rolling return correlation results for pairs of precious metal **spot** prices

	Gold vs Silver	Gold vs Palladium	Gold vs Platinum	Silver vs Palladium	Silver vs Platinum	Palladium vs Platinum
Period 1 (pre-financialisation)	0.394	0.225	0.403	0.296	0.483	0.525
Period 2 (post-financialisation)	0.436	0.302	0.422	0.389	0.505	0.575
% change P1-P2	10.841	34.287	4.766	31.488	4.666	9.664
Period 2 (a)	0.430	0.291	0.367	0.398	0.452	0.585
% change P1-P2(a)	9.265	29.551	-8.870	34.569	-6.374	11.546
Period 2 (b)	0.462	0.335	0.526	0.384	0.573	0.584
% change P1-P2(b)	17.466	49.230	30.413	29.837	18.659	11.328
Period 2 (c)	0.405	0.269	0.383	0.373	0.528	0.532
% change P1-P2(c)	2.914	19.705	-4.901	25.963	9.437	1.319

Table A10: Rolling return correlation results for pairs of energy **spot** prices

	WTI vs Brent	WTI vs Heating Oil	Brent vs Heating Oil
Period 1 (pre-financialisation)	0.550	0.669	0.512
Period 2 (post-financialisation)	0.606	0.707	0.548
% change P1-P2	10.163	5.642	7.202
Period 2 (a)	0.558	0.737	0.504
% change P1-P2(a)	1.521	10.222	-1.450
Period 2 (b)	0.599	0.711	0.582
% change P1-P2(b)	9.013	6.278	13.692
Period 2 (c)	0.750	0.613	0.610
% change P1-P2(c)	36.410	-8.316	19.269

Table A11: Rolling return correlation results for pairs of industrial metal **spot** prices

	LME Cop vs Lead	LME Cop vs Nickel	LME Cop vs Zinc	LME Cop vs Alum	LME Cop vs Tin	Lead vs Nickel	Lead vs Zinc	Lead vs Alum
Period 1 (pre-financialisation)	0.360	0.461	0.415	0.476	0.317	0.404	0.500	0.363
Period 2 (post-financialisation)	0.534	0.543	0.658	0.633	0.424	0.418	0.588	0.452
% change P1-P2	48.243	17.876	58.282	33.042	33.557	3.263	17.455	24.362
Period 2 (a)	0.564	0.577	0.697	0.723	0.447	0.449	0.590	0.493
% change P1-P2(a)	56.778	25.351	67.814	52.095	40.669	11.140	17.947	35.810
Period 2 (b)	0.600	0.576	0.648	0.550	0.389	0.463	0.674	0.479
% change P1-P2(b)	66.695	25.151	55.906	15.541	22.677	14.480	34.650	31.866
Period 2 (c)	0.324	0.385	0.565	0.535	0.425	0.244	0.421	0.285
% change P1-P2(c)	-9.879	-16.506	36.108	12.443	33.956	-39.576	-15.898	-21.531

Table A12: Rolling return correlation results for pairs of industrial metal **spot** prices

	Lead vs Tin	Nickel vs Zinc	Nickel vs Alum	Nickel vs Tin	Zinc vs Alum	Zinc vs Tin	Alum vs Tin
Period 1 (pre-financialisation)	0.329	0.430	0.437	0.366	0.413	0.330	0.344
Period 2 (post-financialisation)	0.349	0.504	0.458	0.381	0.568	0.380	0.349
% change P1-P2	6.161	17.187	4.876	4.053	37.398	15.184	1.485
Period 2 (a)	0.367	0.535	0.506	0.392	0.622	0.396	0.386
% change P1-P2(a)	11.672	24.418	15.776	7.069	50.445	20.018	12.334
Period 2 (b)	0.356	0.519	0.468	0.389	0.539	0.363	0.316
% change P1-P2(b)	8.389	20.704	7.251	6.180	30.408	10.034	-8.005
Period 2 (c)	0.285	0.389	0.306	0.336	0.471	0.367	0.306
% change P1-P2(c)	-13.359	-9.526	-29.952	-8.315	14.002	11.279	-11.128

Table A13: Rolling return correlation results for energy, precious metals, and industrial metals **futures** prices

	WTI vs Gold	WTI vs Silver	WTI vs Pallad	WTI vs Plat	WTI vs CMX Cop	WTI vs LME Cop	WTI vs Alum	WTI vs Zinc	WTI vs Nickel	WTI vs Tin
Period 1 (pre-financialisation)	0.075	0.114	0.026	0.047	0.024	0.024	-0.014	0.033	0.052	0.009
Period 2 (post-financialisation)	0.185	0.217	0.202	0.189	0.275	0.239	0.209	0.179	0.174	0.162
% change P1-P2	146.36	90.72	688.84	301.46	1067.00	886.82	-1609.99	445.33	232.61	1791.77
Period 2 (a)	0.241	0.236	0.167	0.146	0.235	0.200	0.187	0.154	0.158	0.138
% change P1-P2(a)	221.71	107.29	550.90	210.29	897.08	725.37	-1448.14	370.56	201.24	1512.10
Period 2 (b)	0.143	0.223	0.257	0.242	0.328	0.278	0.223	0.202	0.231	0.203
% change P1-P2(b)	90.52	95.74	901.80	411.89	129.16	1046.84	-1710.39	516.22	341.43	2266.74
Period 2 (c)	0.105	0.154	0.200	0.213	0.288	0.276	0.246	0.204	0.114	0.153
% change P1-P2(c)	40.03	35.15	677.50	350.39	1122.76	1039.59	-1874.77	522.05	117.72	1688.46

Table A14: Rolling return correlation results for energy, precious metals, and industrial metals **futures** prices

	Brent vs Gold	Brent vs Silver	Brent vs Plat	Brent vs Pallad	Brent vs CMX Cop	Brent vs LME Cop	Brent vs Alum	Brent vs Zinc	Brent vs Nickel	Brent vs Lead	Brent vs Tin
Period 1 (pre-financialisation)	0.108	0.122	0.072	0.072	0.056	0.041	0.020	0.043	0.050	0.033	0.010
Period 2 (post-financialisation)	0.185	0.217	0.192	0.202	0.276	0.242	0.202	0.184	0.178	0.158	0.169
% change P1-P2	71.18	77.93	168.61	178.54	395.28	484.76	897.74	331.94	255.70	384.13	1651.27
Period 2 (a)	0.247	0.236	0.153	0.171	0.243	0.205	0.181	0.156	0.155	0.166	0.155
% change P1-P2(a)	128.66	93.44	113.39	135.63	337.55	396.13	795.41	266.14	211.09	408.50	1506.33
Period 2 (b)	0.126	0.207	0.230	0.249	0.297	0.260	0.205	0.198	0.216	0.170	0.178
% change P1-P2(b)	16.61	70.11	221.08	243.17	434.12	528.33	910.20	364.48	333.19	421.15	1749.56
Period 2 (c)	0.121	0.182	0.232	0.201	0.325	0.311	0.255	0.237	0.168	0.113	0.190
% change P1-P2(c)	12.36	49.21	225.03	178.03	484.10	650.95	1160.05	454.97	236.03	247.28	1872.75

Table A15: Rolling return correlation results for energy, precious metals, and industrial metals **futures** prices

	Gold vs WTI	Gold vs Brent	Gold vs Heat oil	Gold vs CMX Cop	Gold vs LME Cop	Gold vs Alum	Gold vs Zinc	Gold vs Nickel	Gold vs Lead	Gold vs Tin
Period 1 (pre-financialisation)	0.075	0.108	0.100	0.131	0.091	0.115	0.086	0.038	0.084	0.062
Period 2 (post-financialisation)	0.185	0.185	0.164	0.269	0.221	0.184	0.184	0.163	0.158	0.132
% change P1-P2	146.36	71.18	64.07	105.44	141.81	60.44	115.20	324.91	87.32	113.53
Period 2 (a)	0.241	0.247	0.216	0.279	0.215	0.190	0.192	0.152	0.162	0.128
% change P1-P2(a)	221.71	128.66	115.33	113.46	135.28	66.10	124.25	295.12	91.67	107.01
Period 2 (b)	0.143	0.126	0.122	0.264	0.235	0.181	0.200	0.179	0.193	0.130
% change P1-P2(b)	90.52	16.61	21.65	101.62	157.09	57.81	133.77	364.75	128.85	109.45
Period 2 (c)	0.105	0.121	0.10019	0.249	0.211	0.172	0.133	0.167	0.083	0.148
% change P1-P2(c)	40.03	12.36	-0.02	90.14	131.59	49.55	55.42	333.89	-2.05	139.31

Table A16: Rolling return correlation results for energy, precious metals, and industrial metals **spot** prices

	WTI vs Gold	WTI vs Silver	WTI vs Pallad	WTI vs Plat	WTI vs LME Copper	WTI vs Nickel	WTI vs Alum	WTI vs Zinc	WTI vs Lead	WTI vs Tin
Period 1 (pre-financialisation)	0.037	0.024	-0.015	-0.021	0.027	0.057	-0.022	0.031	0.049	0.009
Period 2 (post-financialisation)	0.139	0.088	0.114	0.125	0.258	0.188	0.230	0.197	0.180	0.169
% change P1-P2	273.26	266.29	-840.08	-687.73	870.66	231.03	-1142.47	540.52	266.63	1830.86
Period 2 (a)	0.157	0.092	0.090	0.123	0.228	0.172	0.212	0.188	0.185	0.159
% change P1-P2(a)	321.09	282.49	-681.92	-675.89	757.21	202.17	-1059.73	513.75	277.02	1712.58
Period 2 (b)	0.131	0.075	0.127	0.126	0.299	0.258	0.255	0.212	0.212	0.198
% change P1-P2(b)	250.08	211.65	-922.48	-689.83	1024.88	354.00	-1252.07	591.25	331.71	2162.00
Period 2 (c)	0.105	0.102	0.159	0.131	0.266	0.104	0.236	0.191	0.106	0.144
% change P1-P2(c)	182.95	322.71	-1127.89	-716.86	900.02	82.80	-1169.41	520.83	116.61	1544.84

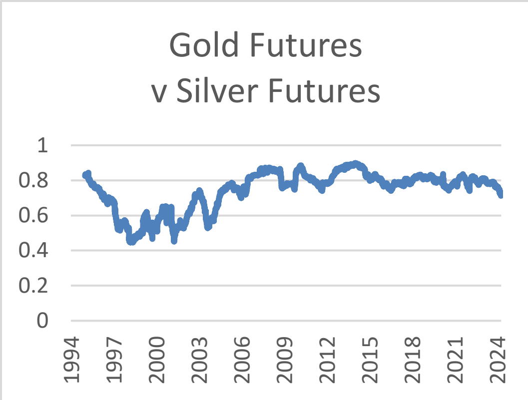
Table A17: Rolling return correlation results for energy, precious metals, and industrial metals **spot** prices

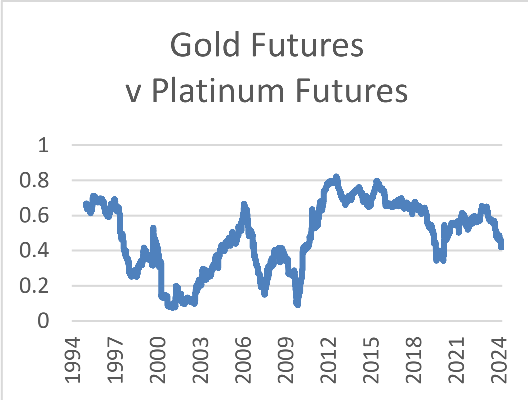
	Brent vs Gold	Brent vs Silver	Brent vs Pallad	Brent vs Plat	Brent vs LME Copper	Brent vs Nickel	Brent vs Alum	Brent vs Zinc	Brent vs Lead	Brent vs Tin
Period 1 (pre-financialisation)	0.046	0.051	0.063	0.009	0.059	0.077	0.002	0.045	0.052	0.028
Period 2 (post-financialisation)	0.159	0.125	0.154	0.179	0.258	0.191	0.221	0.209	0.193	0.180
% change P1-P2	242.40	145.72	145.34	1942.01	334.49	147.41	9347.50	368.54	270.36	537.64
Period 2 (a)	0.200	0.128	0.129	0.190	0.215	0.182	0.200	0.189	0.187	0.166
% change P1-P2(a)	330.97	152.60	106.43	2063.40	261.92	136.29	8445.02	322.51	258.68	487.32
Period 2 (b)	0.134	0.123	0.174	0.165	0.302	0.229	0.233	0.238	0.243	0.201
% change P1-P2(b)	188.73	142.15	178.27	1786.82	408.73	197.59	9896.66	433.69	364.32	613.48
Period 2 (c)	0.091	0.118	0.183	0.175	0.297	0.143	0.256	0.212	0.119	0.180
% change P1-P2(c)	95.17	133.18	192.62	1892.04	398.88	85.08	10843.64	375.75	128.16	536.96

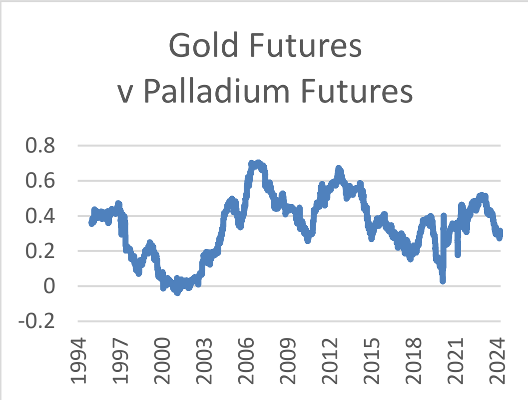
Table A18: Rolling return correlation results for energy, precious metals, and industrial metals **spot** prices

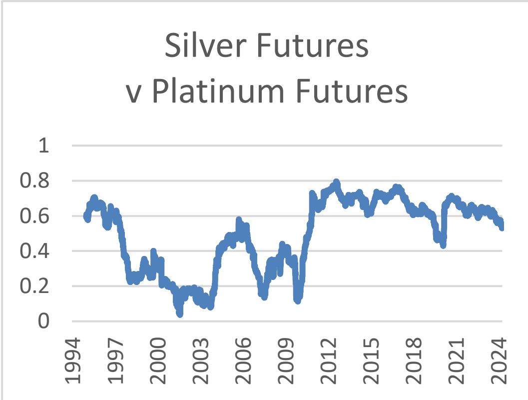
	Gold vs LME Copper	Gold vs Nickel	Gold vs Alum	Gold vs Zinc	Gold vs Lead	Gold vs Tin	Gold vs WTI	Gold vs Brent	Gold vs Heat Oil
Period 1 (pre-financialisation)	0.121	0.076	0.140	0.112	0.060	0.088	0.037	0.046	0.032
Period 2 (post-financialisation)	0.246	0.185	0.199	0.211	0.189	0.168	0.139	0.159	0.126
% change P1-P2	104.31	143.34	42.04	89.12	216.16	91.14	273.26	242.40	300.16
Period 2 (a)	0.255	0.180	0.223	0.226	0.192	0.158	0.157	0.200	0.144
% change P1-P2(a)	111.78	137.02	59.05	102.62	220.31	79.42	321.09	330.97	356.99
Period 2 (b)	0.250	0.200	0.190	0.214	0.229	0.192	0.131	0.134	0.128
% change P1-P2(b)	107.38	163.16	35.74	91.50	282.29	118.65	250.08	188.73	305.44
Period 2 (c)	0.214	0.171	0.149	0.164	0.109	0.152	0.105	0.091	0.073
% change P1-P2(c)	77.78	124.10	6.15	47.06	81.56	72.69	182.95	95.17	131.81

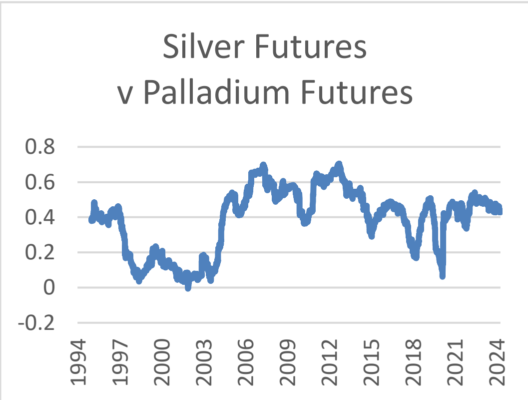
Appendix B: Same-Sector Pairwise Rolling Return Correlation of Futures Prices

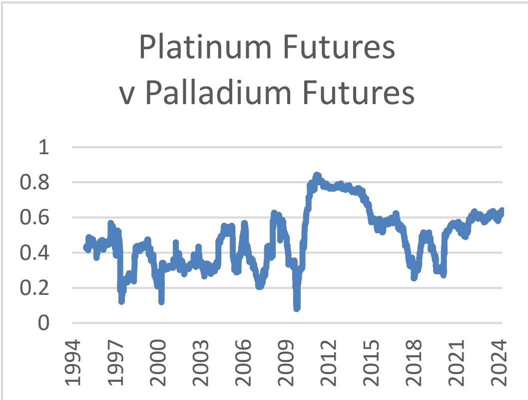


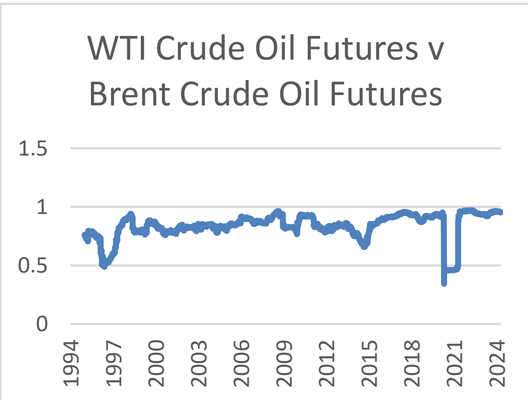


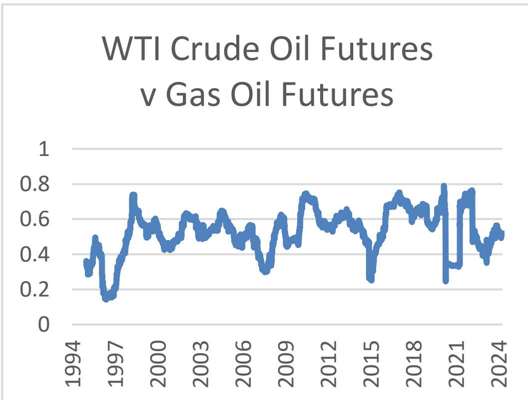


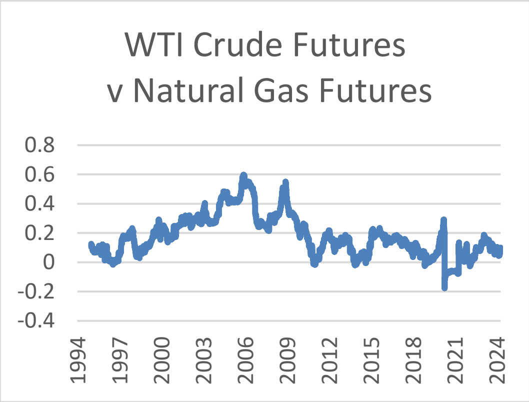








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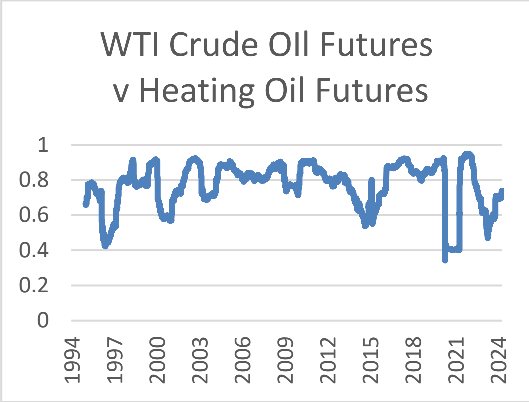
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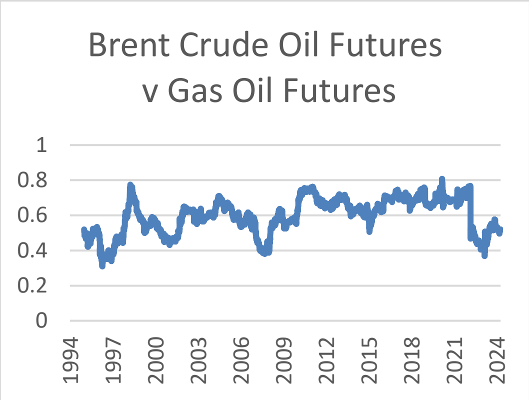
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v Gas Oil Futures
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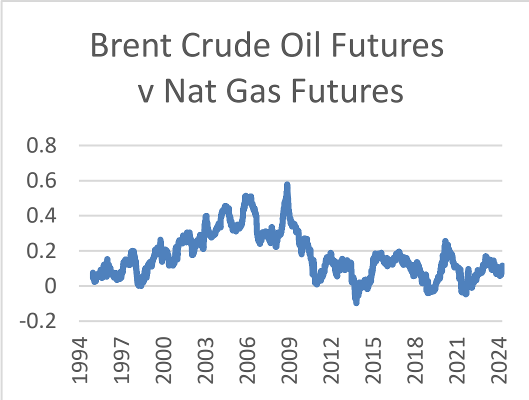
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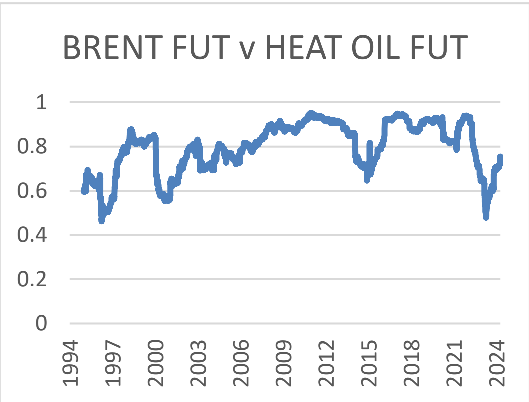
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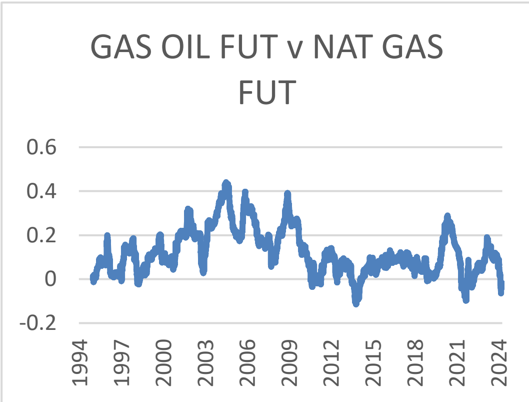
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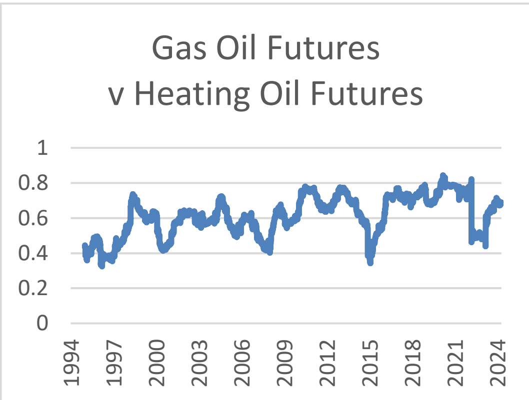
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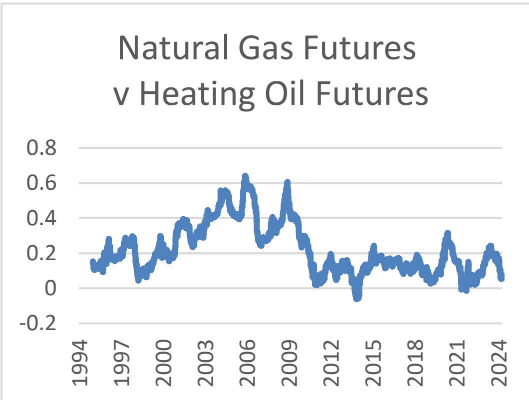
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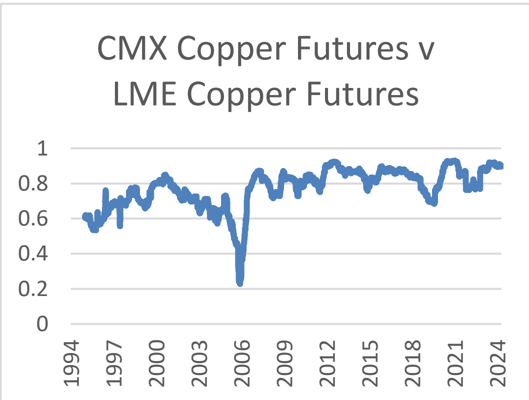
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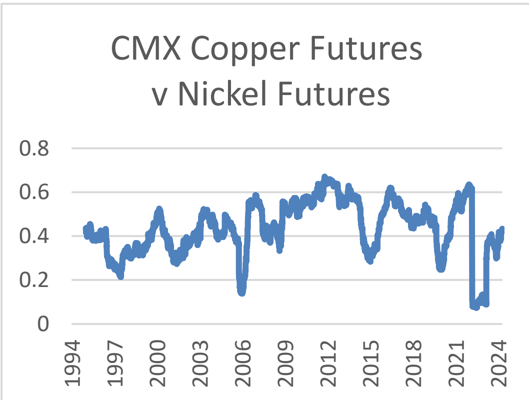
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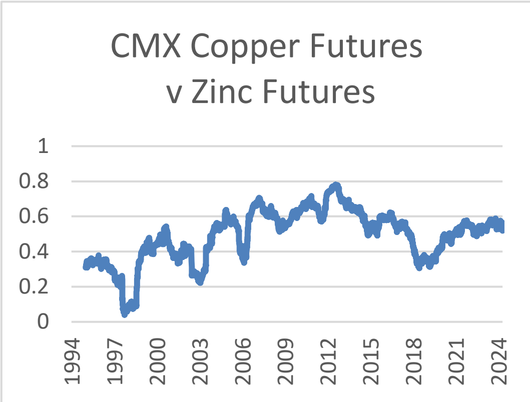
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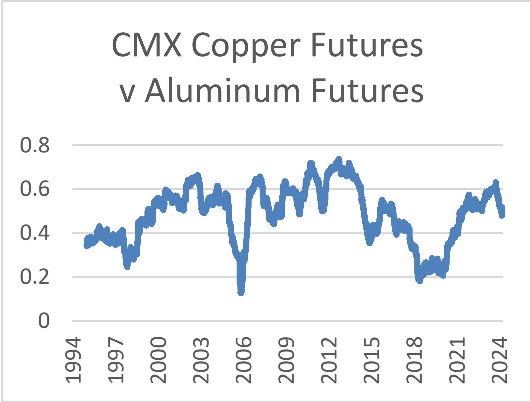
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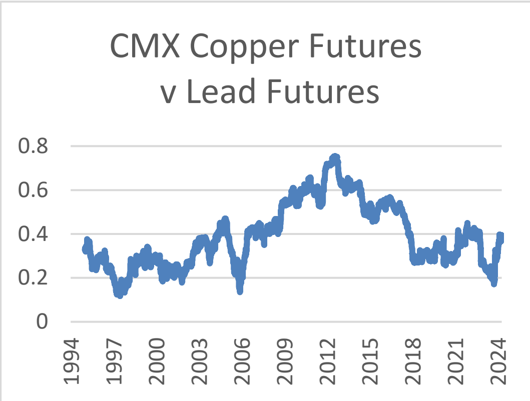
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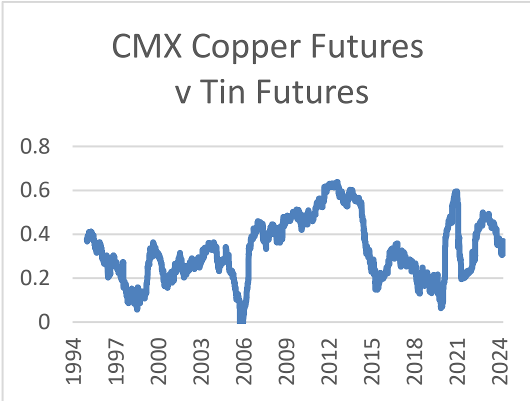
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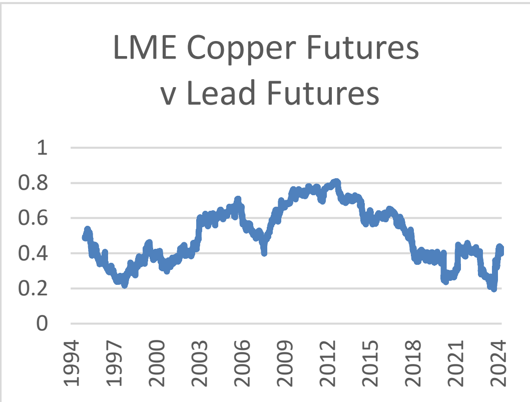
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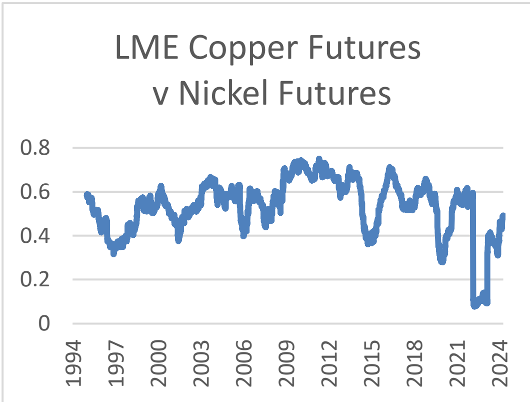
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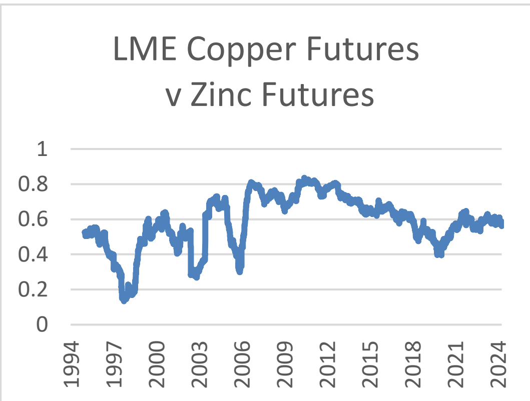
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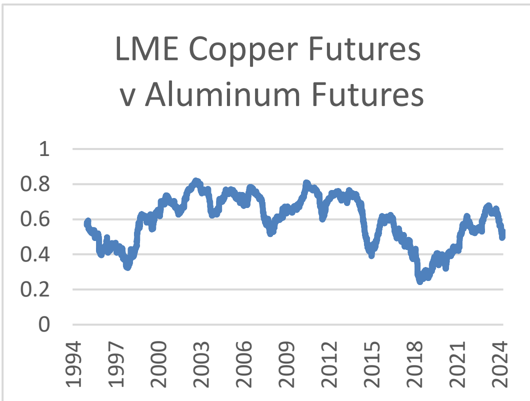
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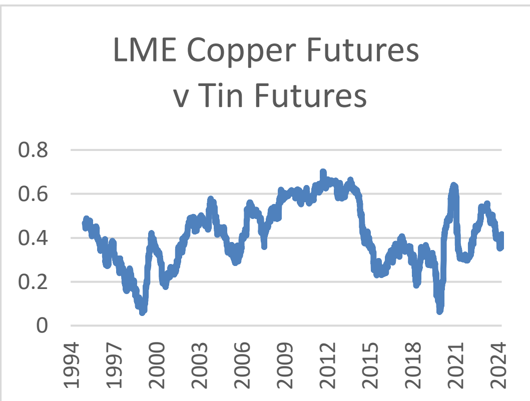
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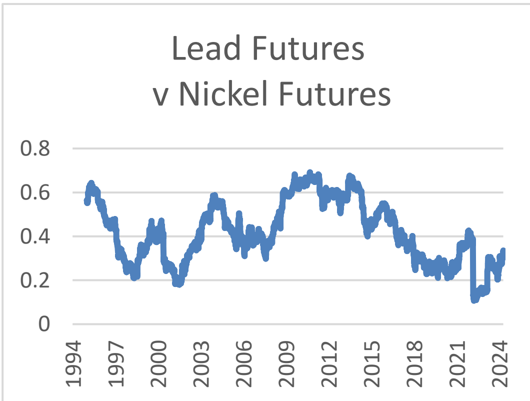
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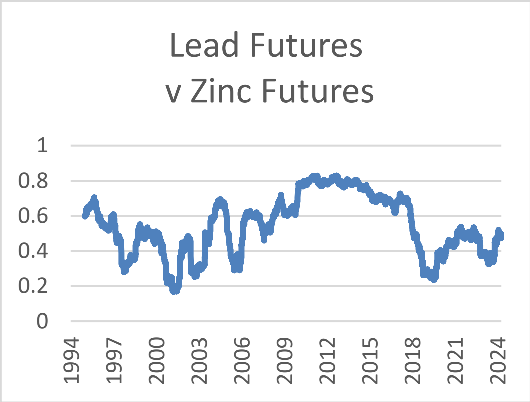
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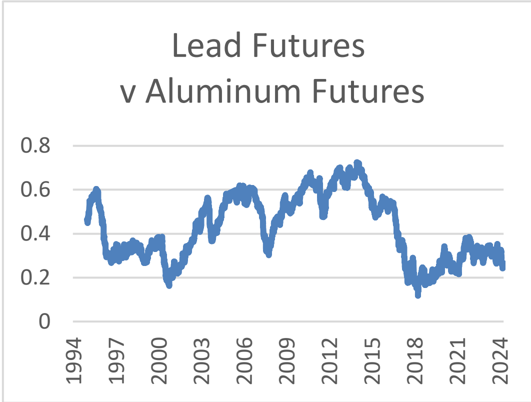
Lead Futures
v Aluminum Futures
0.8
0.6
0.4
0.2
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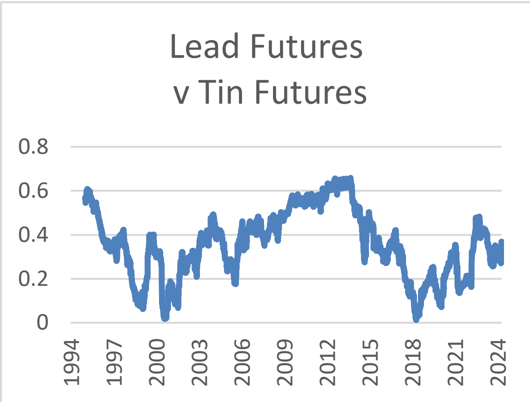
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024


Lead Futures
v Tin Futures
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0.6
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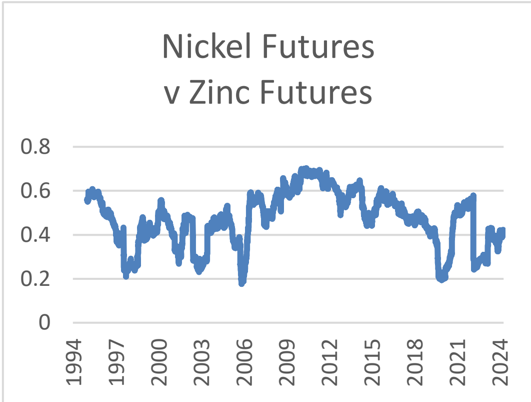
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024


Nickel Futures
v Zinc Futures
0.8
0.6
0.4
0.2
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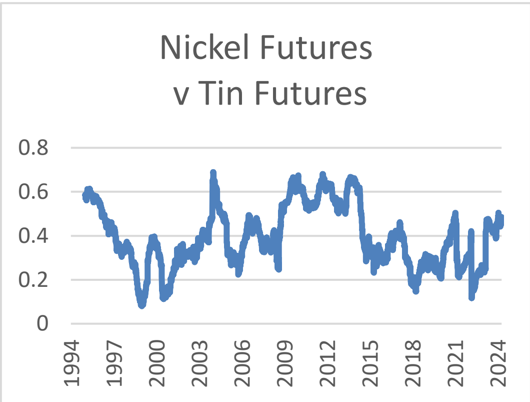
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024


Nickel Futures
v Tin Futures
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0.6
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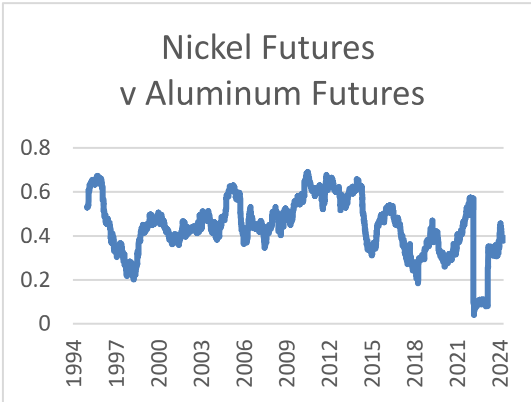
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024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v Aluminum Futures
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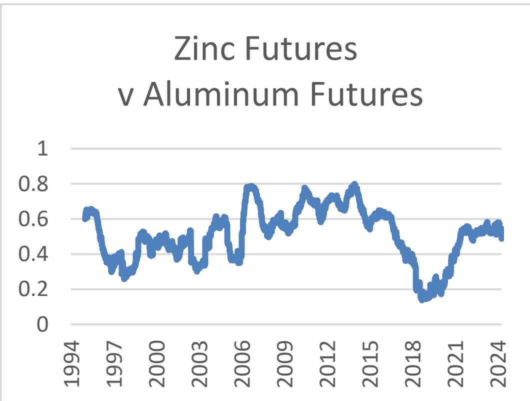
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024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v Aluminum Futures
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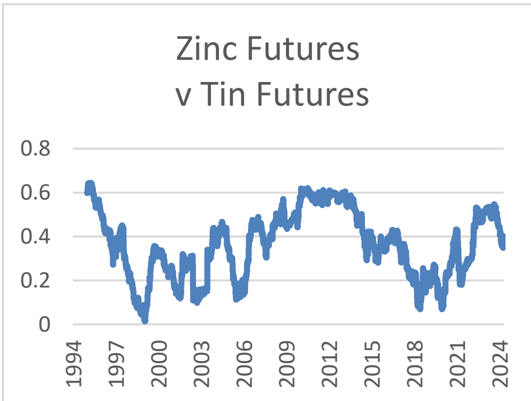
Zinc Futures
v Tin Futures
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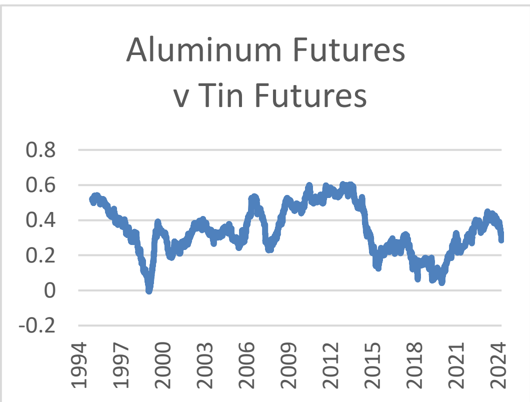
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024


Aluminum Futures
v Tin Futures
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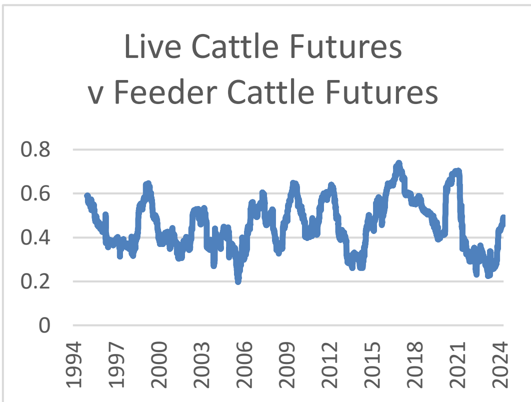
0.4
0.2
0
-0.2
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024


Live Cattle Futures
v Feeder Cattle Futures
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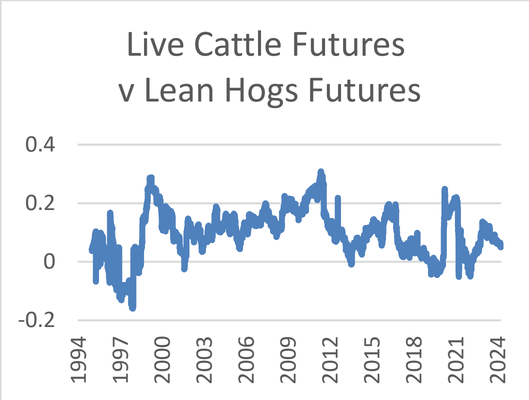
0.6
0.4
0.2
0
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024


Live Cattle Futures
v Lean Hogs Futures
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0.2
0
-0.2
1994
1997
2000
2003
2006
2009
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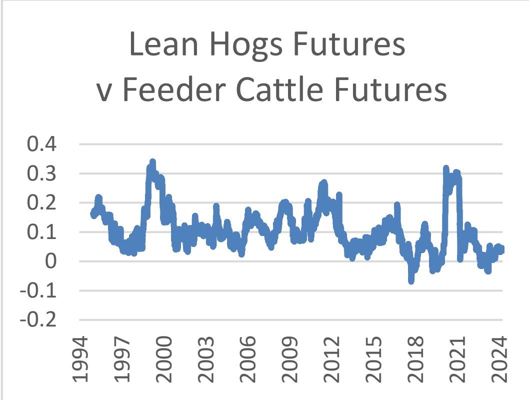
2015
2018
2021
2024


Lean Hogs Futures
v Feeder Cattle Futures
0.4
0.3
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0.1
0
-0.1
-0.2
1994
1997
2000
2003
2006
2009
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2015
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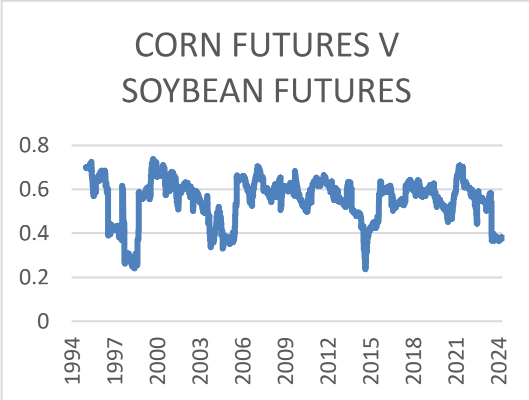
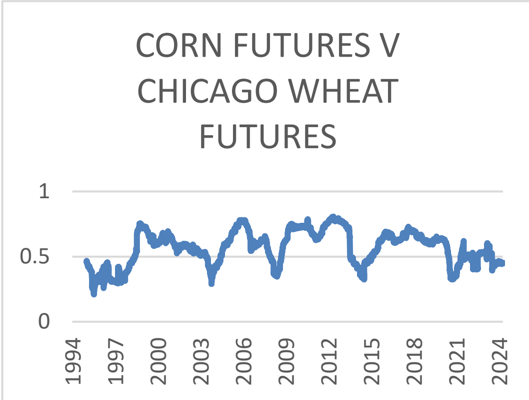

CORN FUTURES V
SOYBEAN FUTURES
0.8
0.6
0.4
0.2
0
1994
1997
2000
2003
2006
2009
2012
2015
2018
2021
2024


CORN FUTURES V
CHICAGO WHEAT
FUTURES
1
0.5
0
1994
1997
2000
2003
2006
2009
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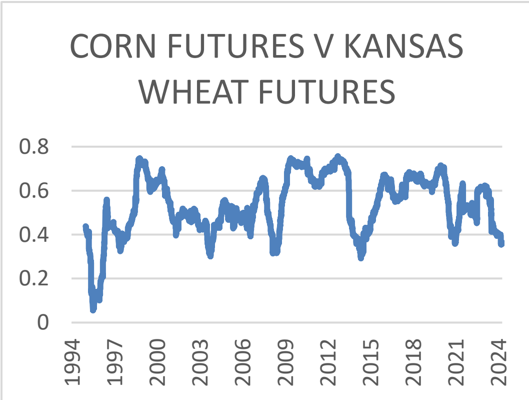
2015
2018
2021
2024


CORN FUTURES V KANSAS
WHEAT FUTURES
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0.4
0.2
0
1994
1997
2000
2003
2006
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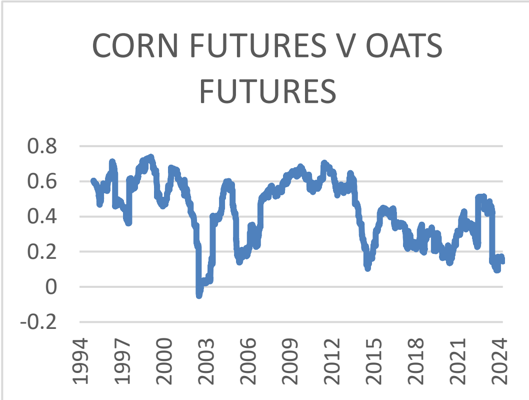
2021
2024


CORN FUTURES V OATS
FUTURES
0.8
0.6
0.4
0.2
0
-0.2
1994
1997
2000
2003
2006
2009
2012
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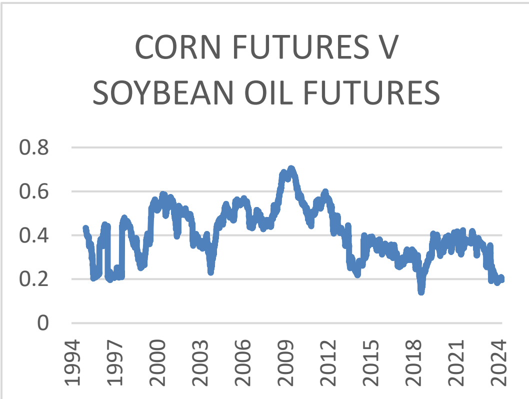
CORN FUTURES V
SOYBEAN OIL FUTURES
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0.2
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2003
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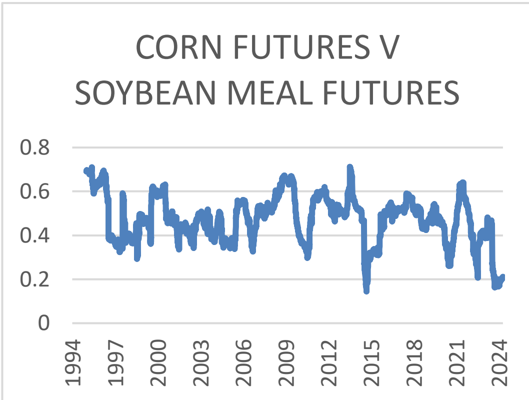
2021
2024


CORN FUTURES V
SOYBEAN MEAL FUTURES
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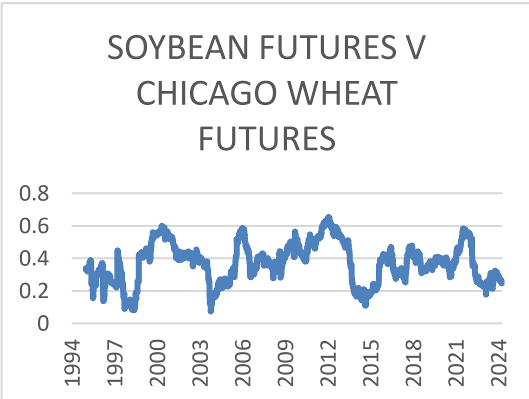
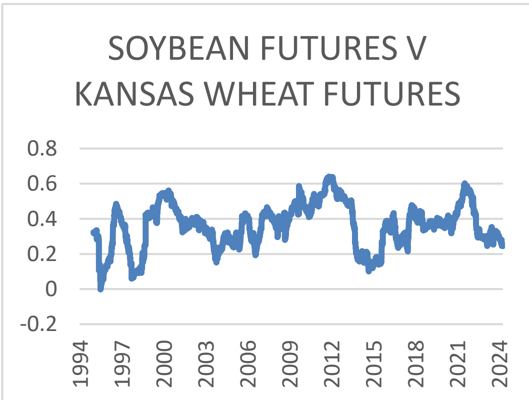
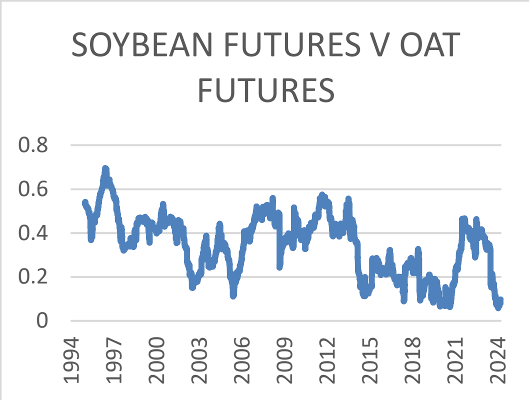
0.6
0.4
0.2
0
1994
1997
2000
2003
2006
2009
2012
2015
2018
2021
2024


SOYBEAN FUTURES V
CHICAGO WHEAT
FUTURES
0.8
0.6
0.4
0.2
0
1994
1997
2000
2003
2006
2009
2012
2015
2018
2021
2024


SOYBEAN FUTURES V
KANSAS WHEAT FUTURES
0.8
0.6
0.4
0.2
0
-0.2
1994
1997
2000
2003
2006
2009
2012
2015
2018
2021
2024


SOYBEAN FUTURES V OAT FUTURES
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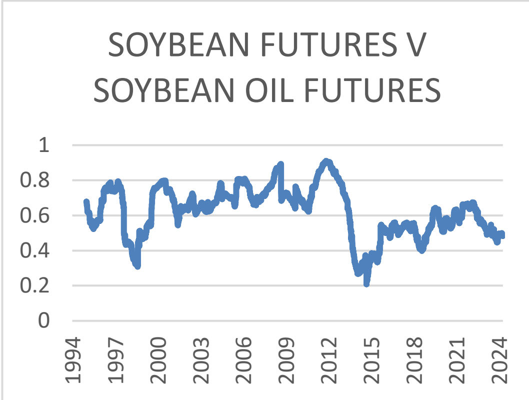
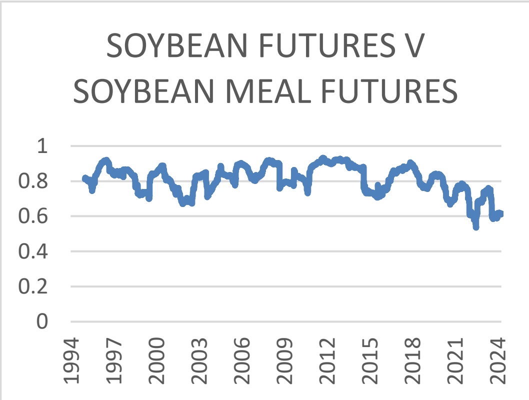
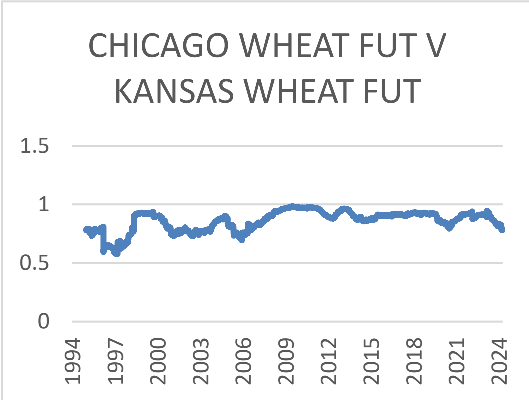
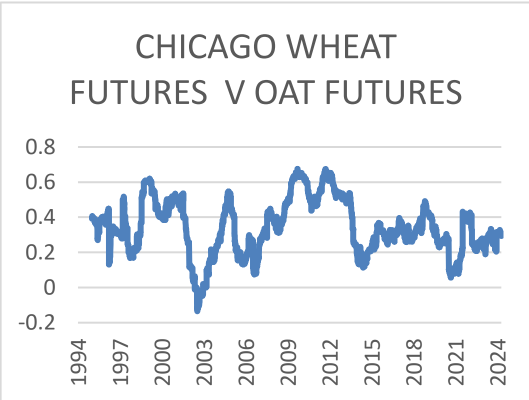
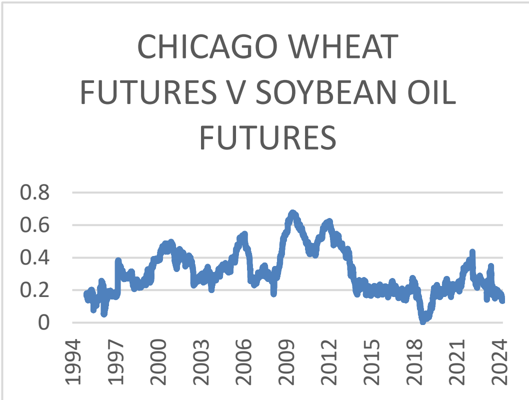
0.6
0.4
0.2
0
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024


SOYBEAN FUTURES V SOYBEAN OIL FUTURES
1
0.8
0.6
0.4
0.2
0
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024


SOYBEAN FUTURES V SOYBEAN MEAL FUTURES
1
0.8
0.6
0.4
0.2
0
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024


CHICAGO WHEAT FUT V KANSAS WHEAT FUT
1.5
1
0.5
0
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024


CHICAGO WHEAT FUTURES V OAT FUTURES
0.8
0.6
0.4
0.2
0
-0.2
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024


CHICAGO WHEAT FUTURES V SOYBEAN OIL FUTURES
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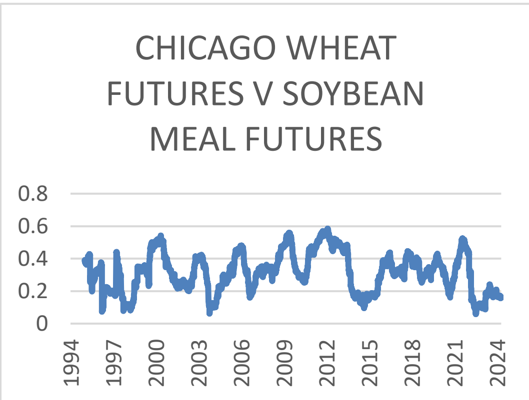
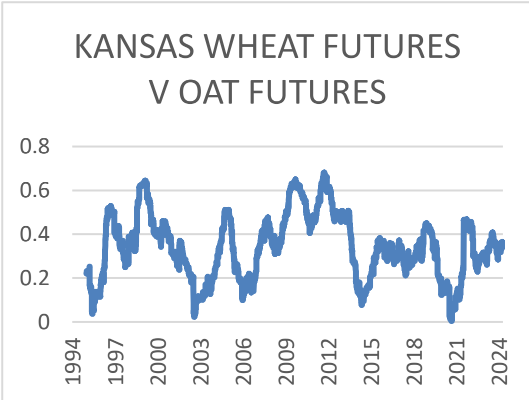
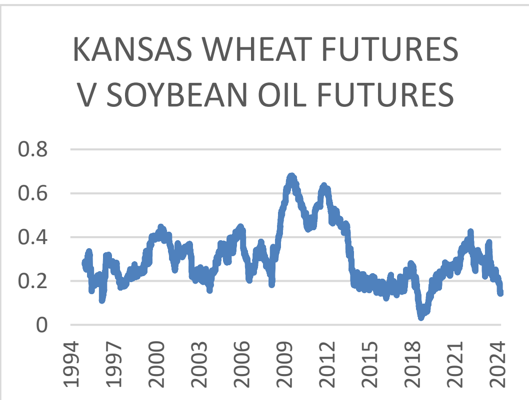
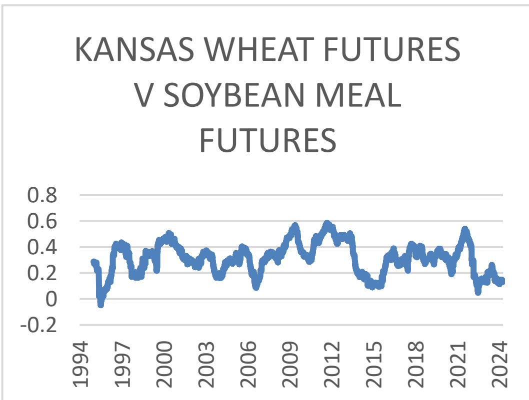
0.6
0.4
0.2
0
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024


CHICAGO WHEAT FUTURES V SOYBEAN MEAL FUTURES
0.8
0.6
0.4
0.2
0
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024


KANSAS WHEAT FUTURES V OAT FUTURES
0.8
0.6
0.4
0.2
0
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024


KANSAS WHEAT FUTURES V SOYBEAN OIL FUTURES
0.8
0.6
0.4
0.2
0
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024


KANSAS WHEAT FUTURES V SOYBEAN MEAL FUTURES
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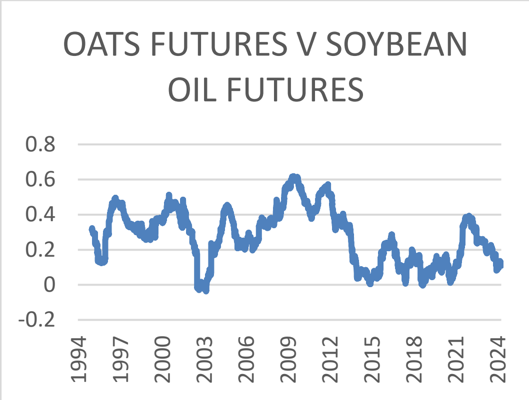
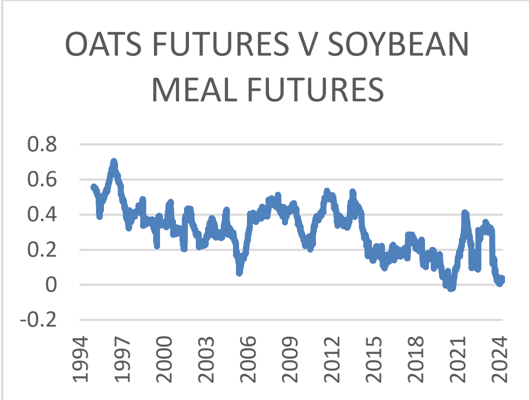
0.6
0.4
0.2
0
-0.2
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024


OATS FUTURES V SOYBEAN OIL FUTURES
0.8
0.6
0.4
0.2
0
-0.2
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024


OATS FUTURES V SOYBEAN MEAL FUTURES
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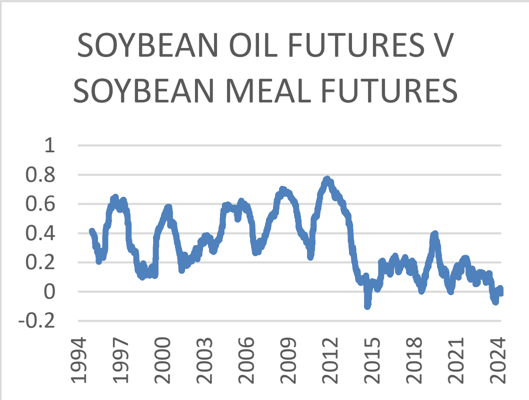
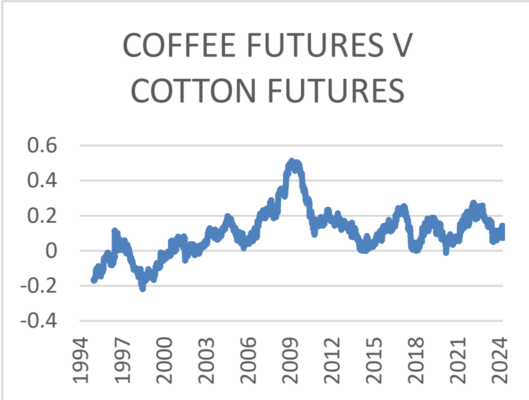
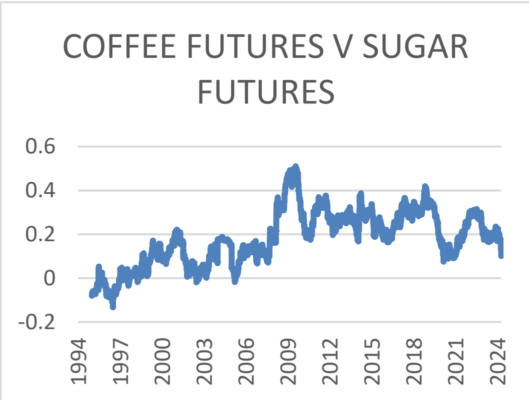
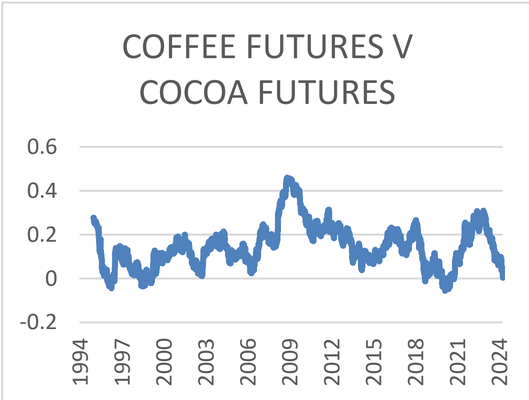
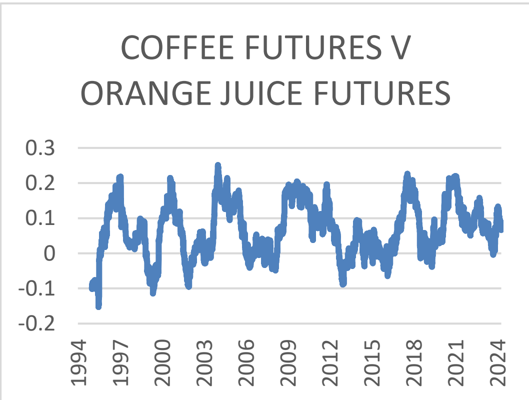
0.6
0.4
0.2
0
-0.2
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024

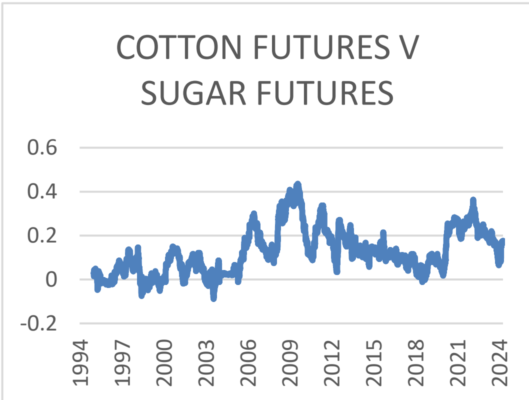

SOYBEAN OIL FUTURES V SOYBEAN MEAL FUTURES
1
0.8
0.6
0.4
0.2
0
-0.2
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024

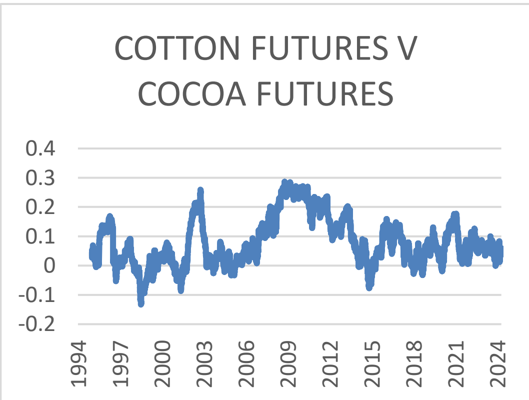

COFFEE FUTURES V COTTON FUTURES
0.6
0.4
0.2
0
-0.2
-0.4
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024

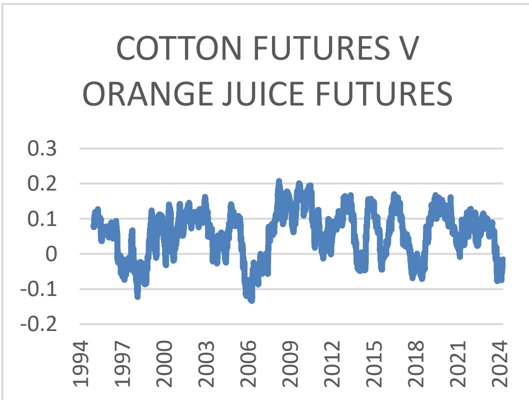

COFFEE FUTURES V SUGAR FUTURES
0.6
0.4
0.2
0
-0.2
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024

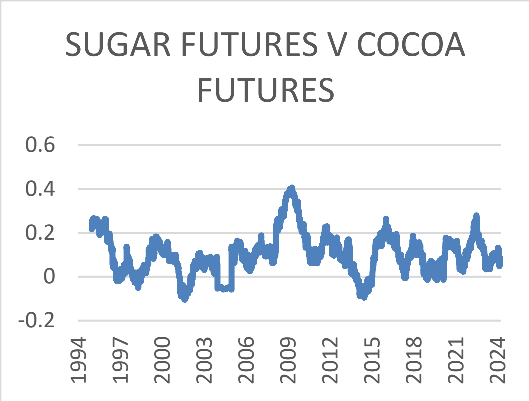

COFFEE FUTURES V COCOA FUTURES
0.6
0.4
0.2
0
-0.2
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024

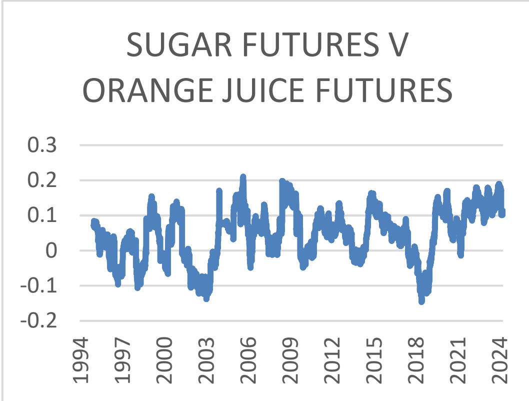

COFFEE FUTURES V ORANGE JUICE FUTURES
0.3
0.2
0.1
0
-0.1
-0.2
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024

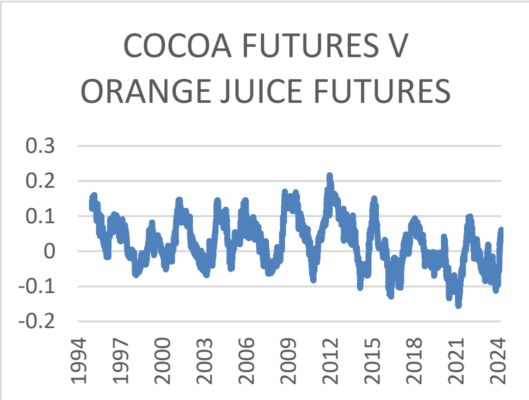

COTTON FUTURES V SUGAR FUTURES
0.6
0.4
0.2
0
-0.2
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024


COTTON FUTURES V COCOA FUTURES
0.4
0.3
0.2
0.1
0
-0.1
-0.2
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024

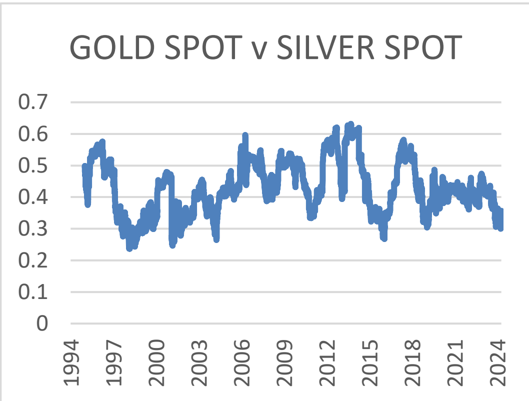

COTTON FUTURES V ORANGE JUICE FUTURES
0.3
0.2
0.1
0
-0.1
-0.2
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024

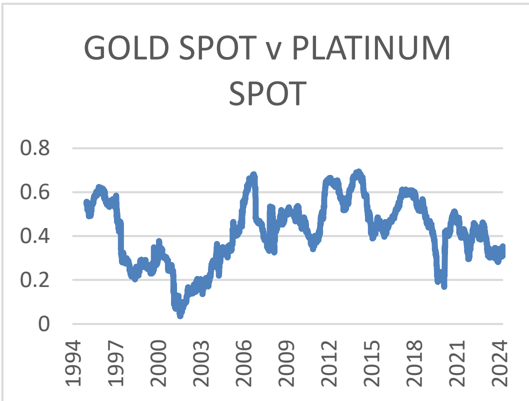


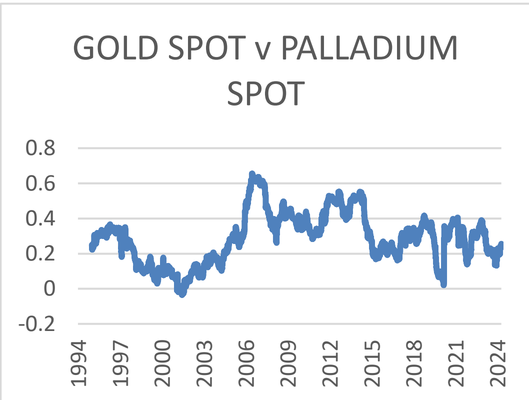


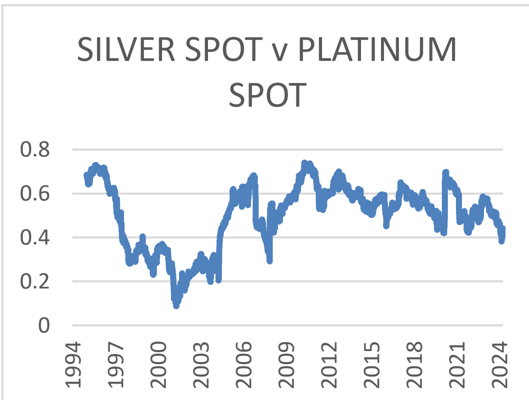


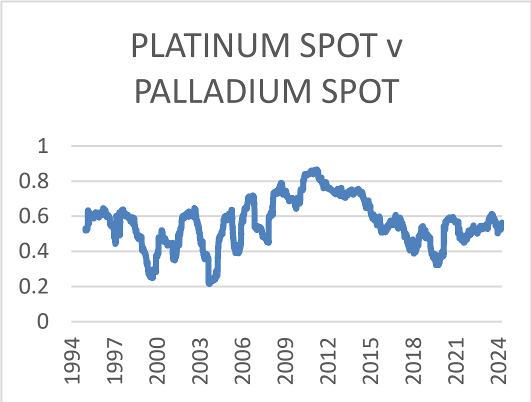
Appendix C: Same-Sector Pairwise Rolling Return Correlation of Spot Prices

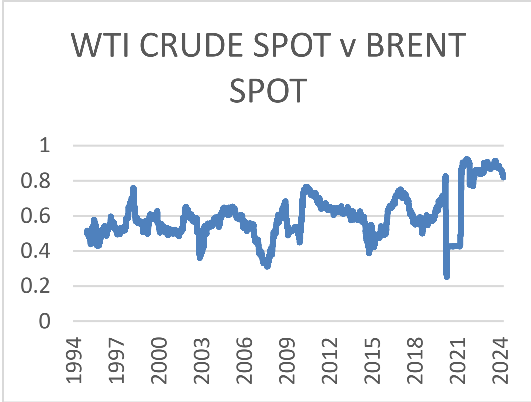


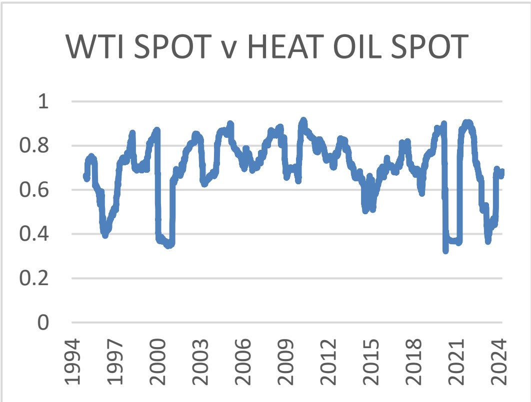


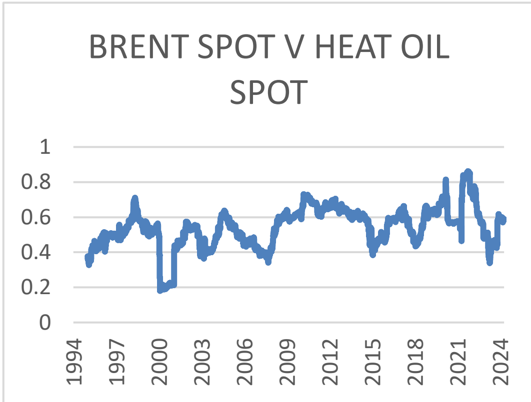


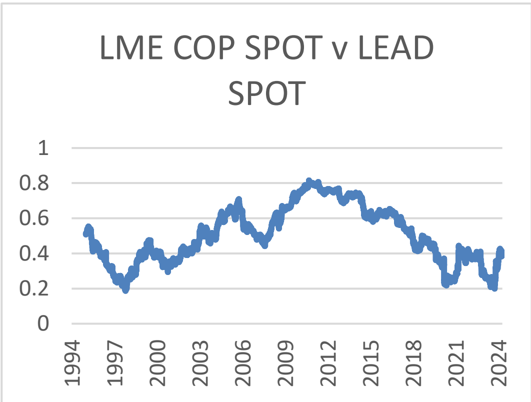


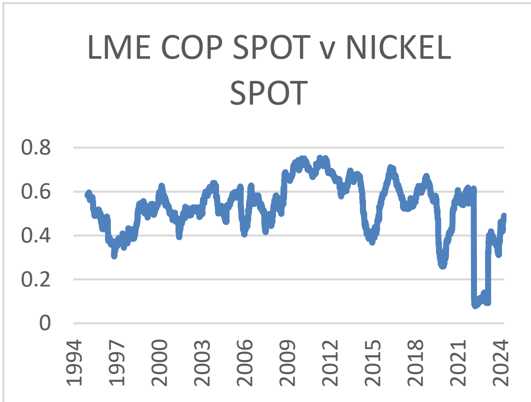

PLATINUM SPOT v PALLADIUM SPOT
1
0.8
0.6
0.4
0.2
0
1994
1997
2000
2003
2006
2009
2012
2015
2018
2021
2024


WTI CRUDE SPOT v BRENT SPOT
1
0.8
0.6
0.4
0.2
0
1994
1997
2000
2003
2006
2009
2012
2015
2018
2021
2024


WTI SPOT v HEAT OIL SPOT
1
0.8
0.6
0.4
0.2
0
1994
1997
2000
2003
2006
2009
2012
2015
2018
2021
2024


BRENT SPOT V HEAT OIL SPOT
1
0.8
0.6
0.4
0.2
0
1994
1997
2000
2003
2006
2009
2012
2015
2018
2021
2024


LME COP SPOT v LEAD SPOT
1
0.8
0.6
0.4
0.2
0
1994
1997
2000
2003
2006
2009
2012
2015
2018
2021
2024


LME COP SPOT v NICKEL SPOT
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0.4
0.2
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1994
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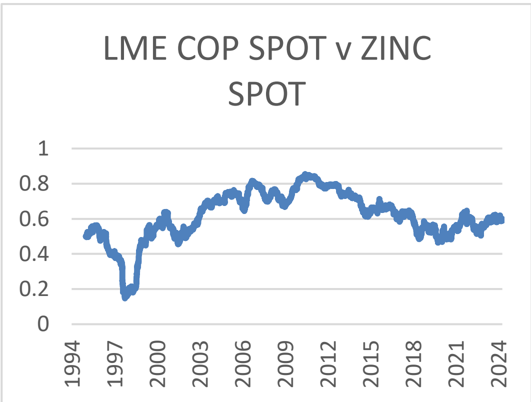
2024


LME COP SPOT v ZINC SPOT
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0.4
0.2
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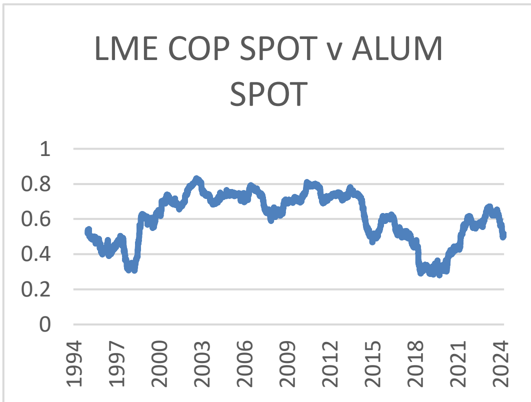
LME COP SPOT v ALUM SPOT
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2021
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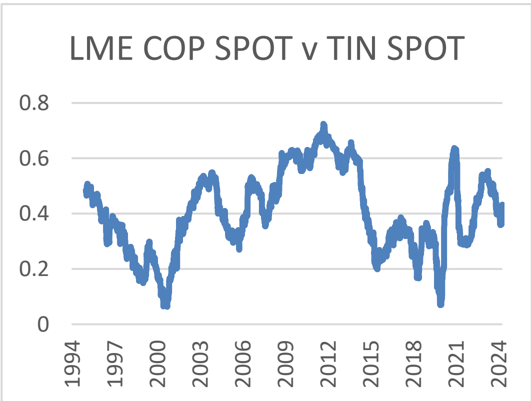
LME COP SPOT v TIN SPOT
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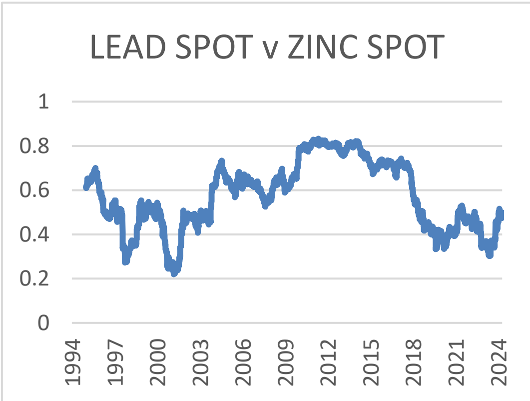
LEAD SPOT v ZINC SPOT
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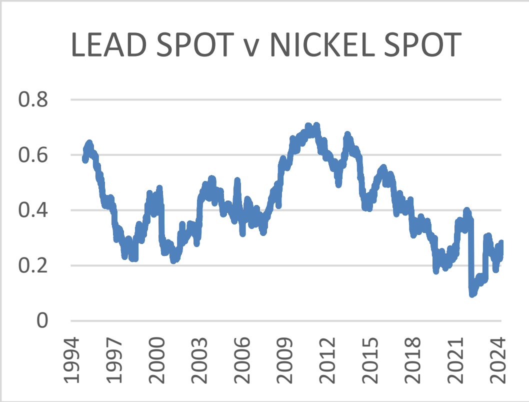
LEAD SPOT v NICKEL SPOT
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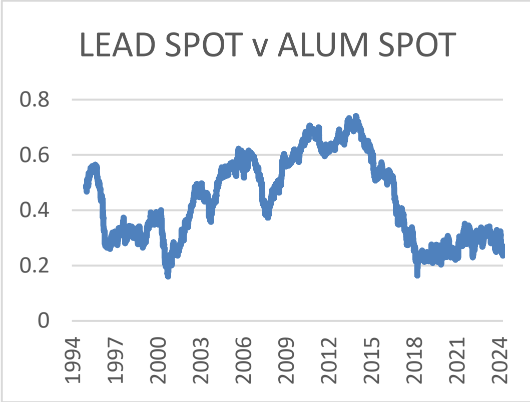
LEAD SPOT v ALUM SPOT
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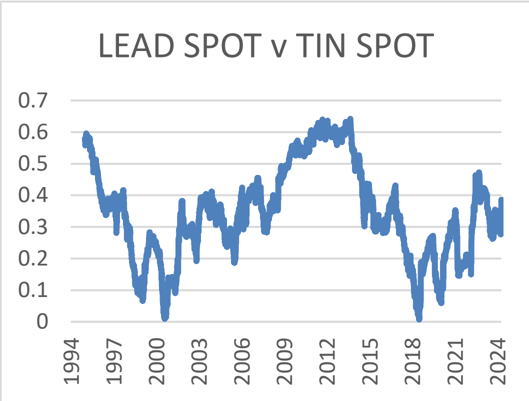
LEAD SPOT v TIN SPOT
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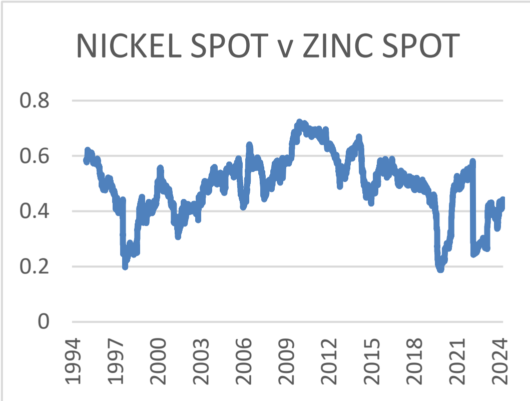
NICKEL SPOT v ZINC SPOT
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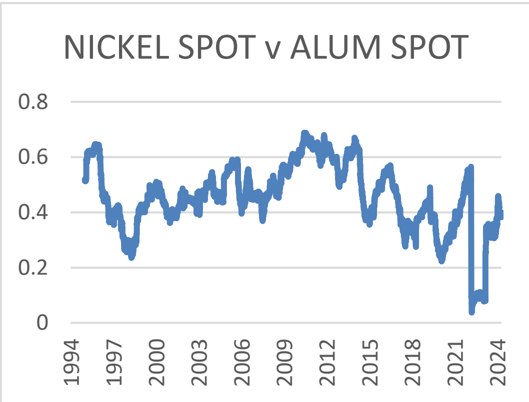
NICKEL SPOT v ALUM SPOT
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1994
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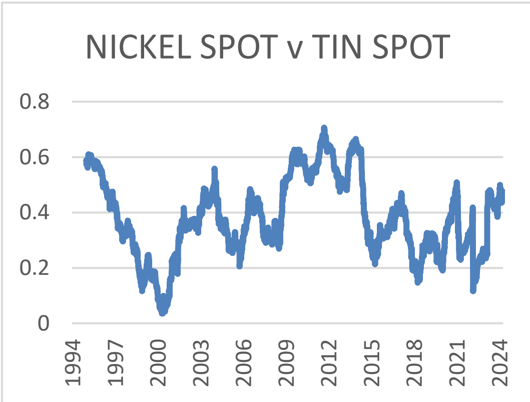
NICKEL SPOT v TIN SPOT
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2003
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2021
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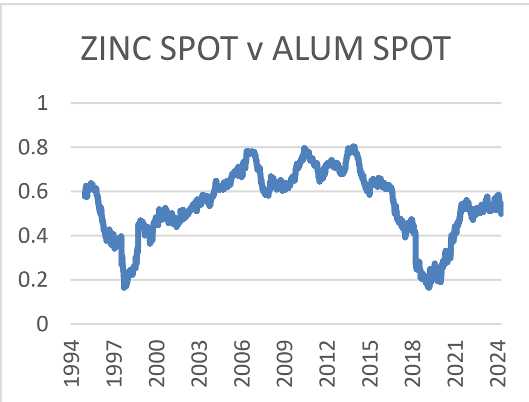
ZINC SPOT v ALUM SPOT
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0.8
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0.4
0.2
0
1994
1997
2000
2003
2006
2009
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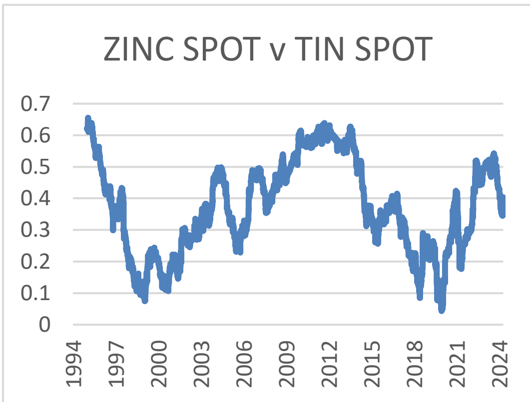
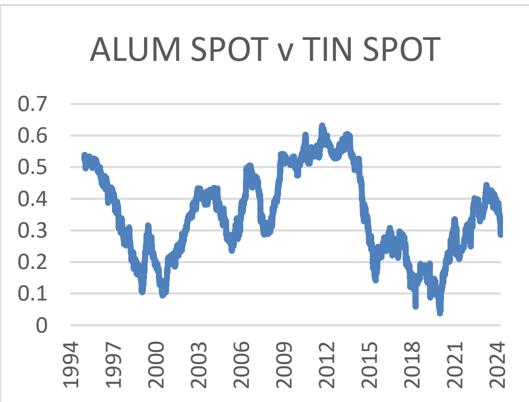
2021
2024


ZINC SPOT v TIN SPOT
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1994
1997
2000
2003
2006
2009
2012
2015
2018
2021
2024


ALUM SPOT v TIN SPOT
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1994
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2000
2003
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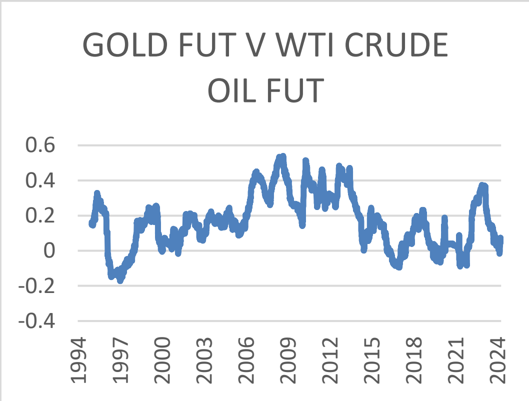
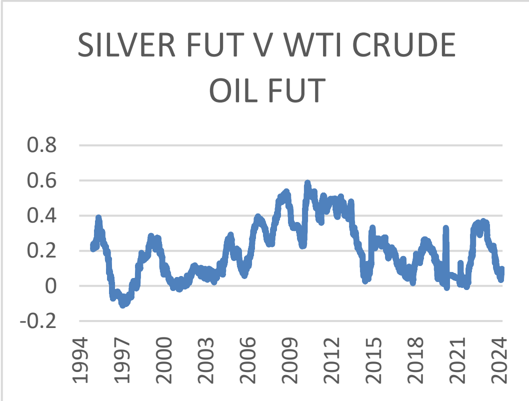
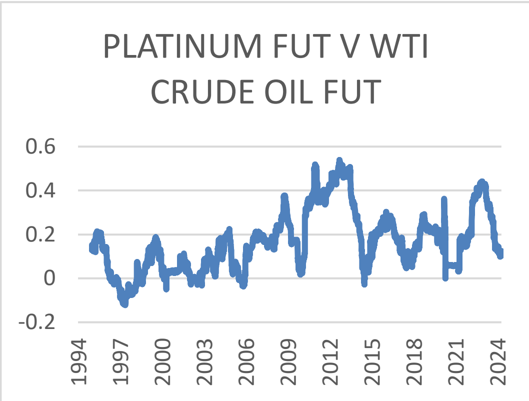
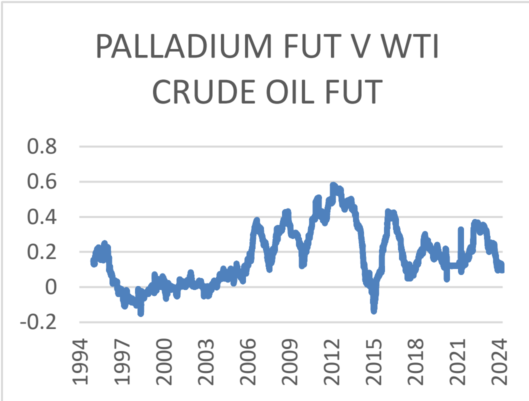
2012
2015
2018
2021
2024

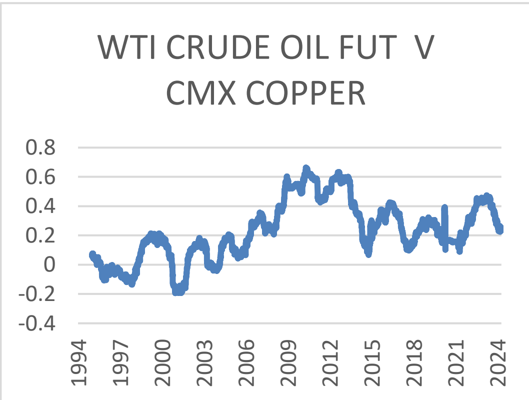
Appendix D: Cross-Sector Pairwise Rolling Return Correlation of Futures Prices

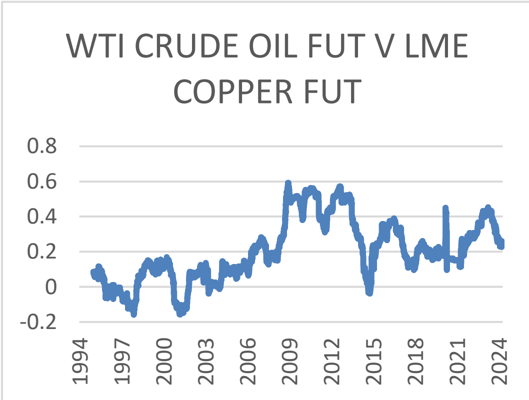


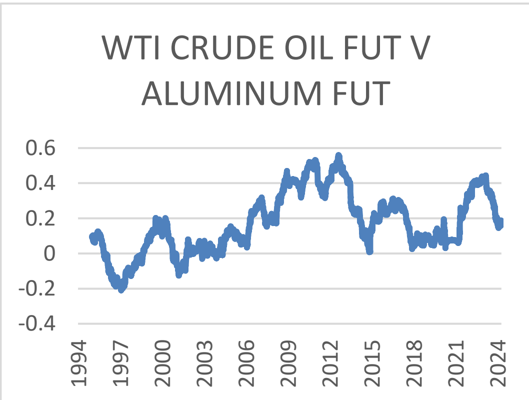


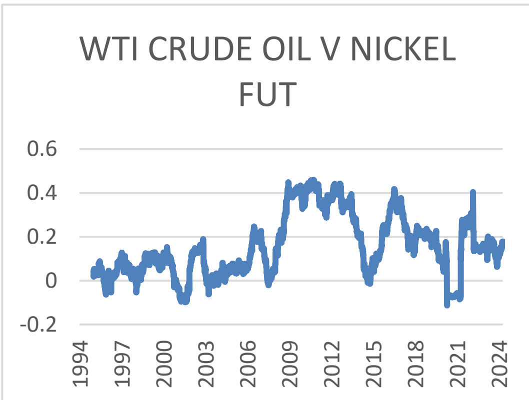


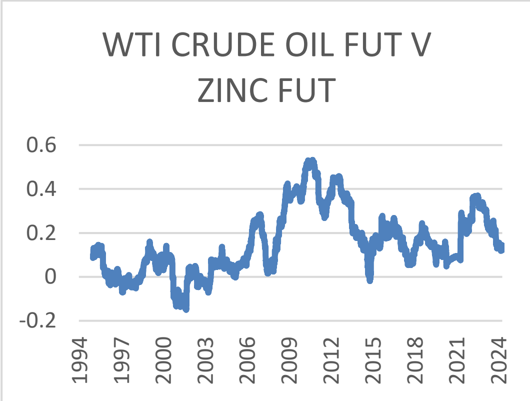








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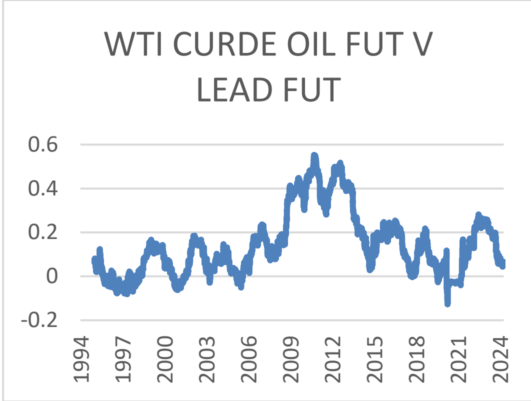
0.4
0.2
0
-0.2
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024


WTI CURDE OIL FUT V LEAD FUT
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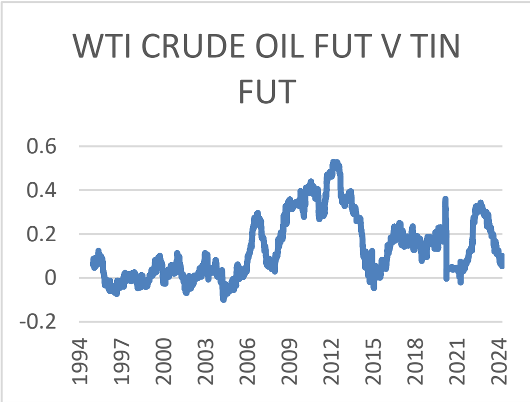
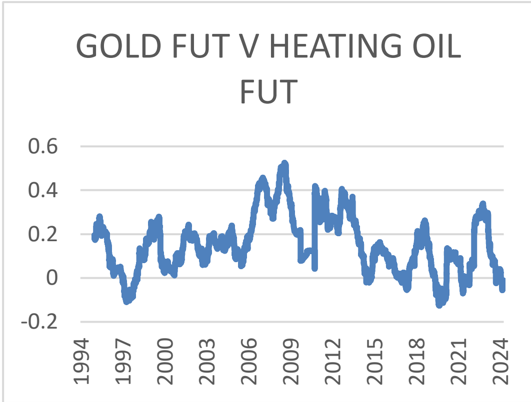
0.4
0.2
0
-0.2
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024


WTI CRUDE OIL FUT V TIN FUT
0.6
0.4
0.2
0
-0.2
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024


GOLD FUT V HEATING OIL FUT
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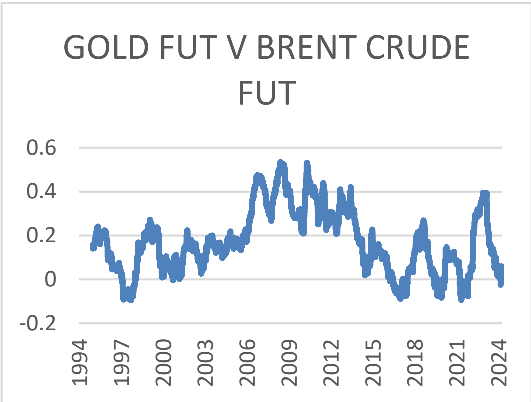
0.4
0.2
0
-0.2
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024


GOLD FUT V BRENT CRUDE FUT
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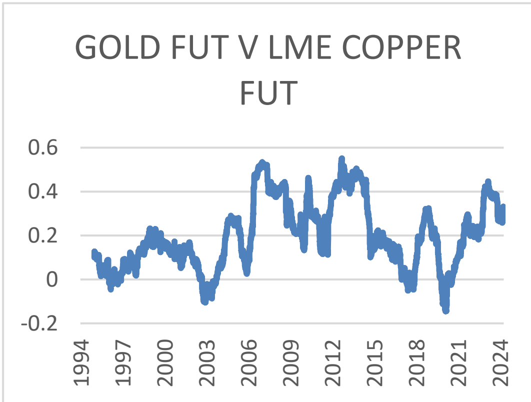
0.2
0
-0.2
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024


GOLD FUT V LME COPPER FUT
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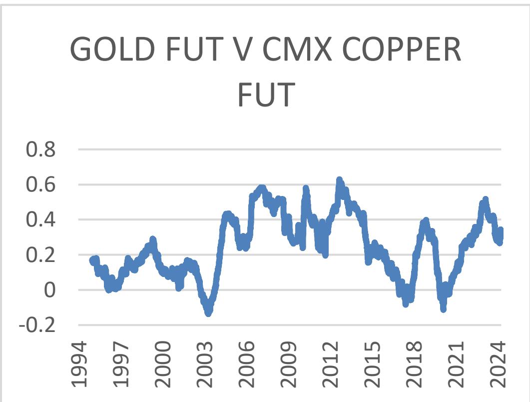
0.2
0
-0.2
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024


GOLD FUT V CMX COPPER FUT
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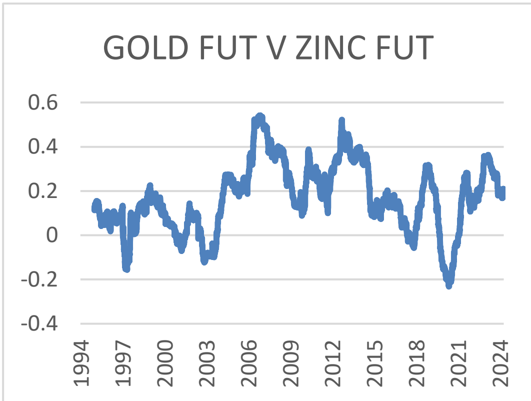
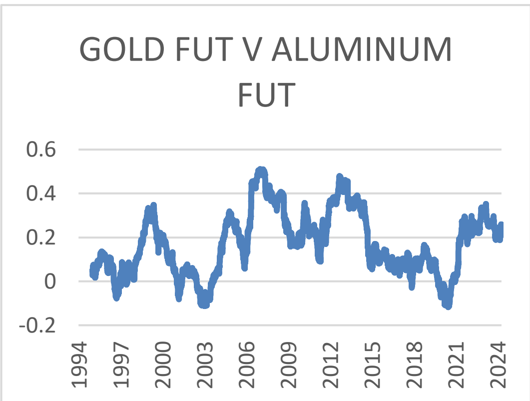
0.6
0.4
0.2
0
-0.2
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024


GOLD FUT V ZINC FUT
0.6
0.4
0.2
0
-0.2
-0.4
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024


GOLD FUT V ALUMINUM FUT
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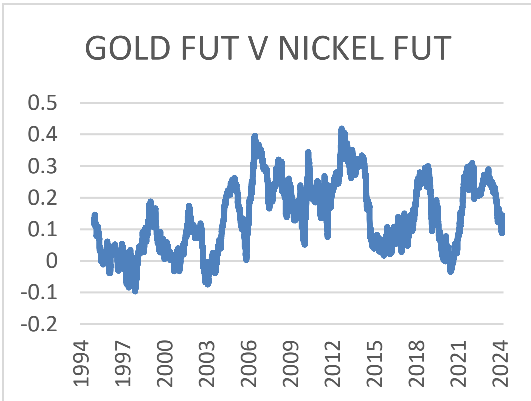
0.2
0
-0.2
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024


GOLD FUT V NICKEL FUT
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0.4
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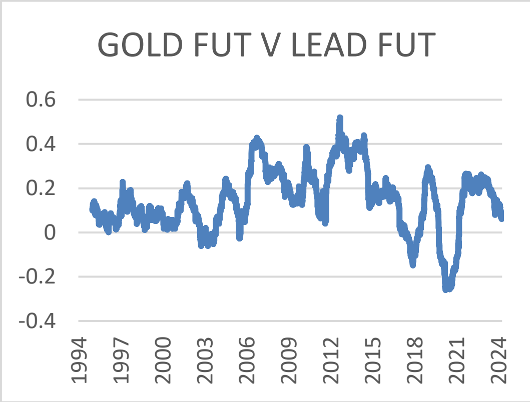
0.2
0.1
0
-0.1
-0.2
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024


GOLD FUT V LEAD FUT
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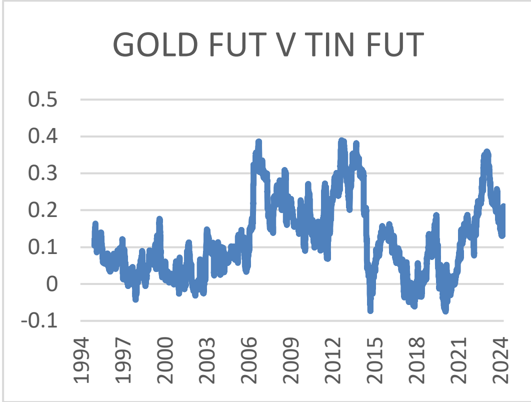
0.2
0
-0.2
-0.4
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024


GOLD FUT V TIN FUT
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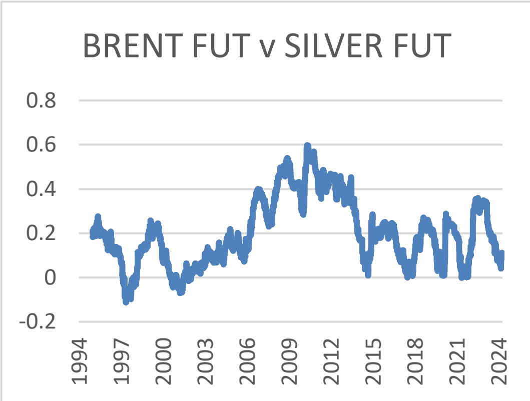
-0.1
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024


BRENT FUT v SILVER FUT
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0.4
0.2
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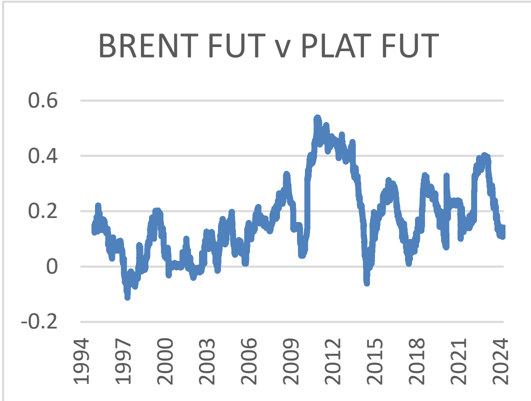
-0.2
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024


BRENT FUT v PLAT FUT
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0.4
0.2
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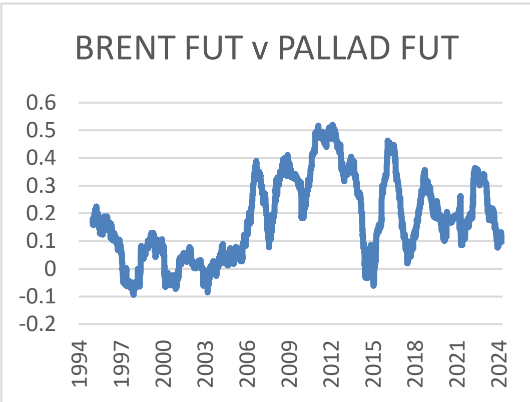
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024


BRENT FUT v PALLAD FUT
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0.4
0.3
0.2
0.1
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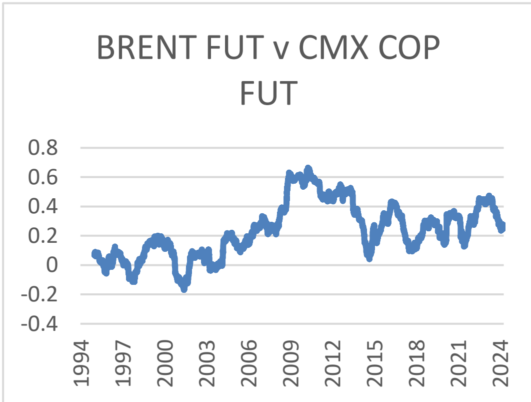
-0.1
-0.2
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024


BRENT FUT v CMX COP FUT
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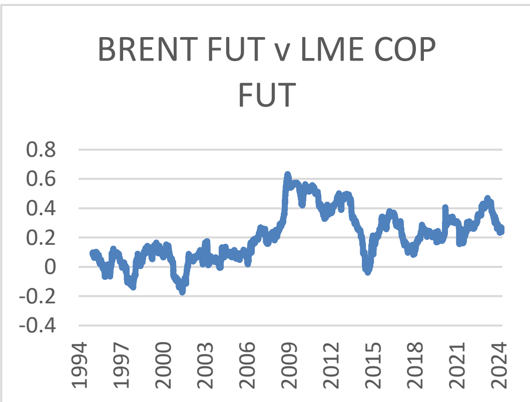
0.6
0.4
0.2
0
-0.2
-0.4
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024


BRENT FUT v LME COP FUT
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0.2
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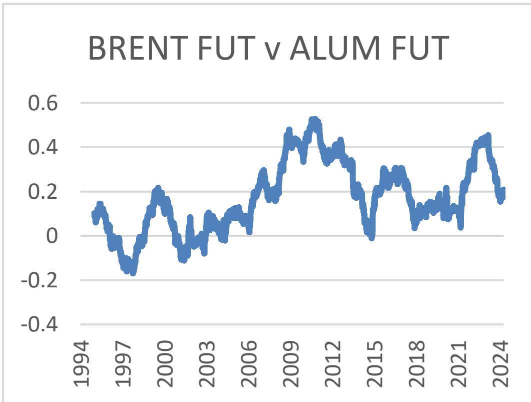
-0.2
-0.4
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024


BRENT FUT v ALUM FUT
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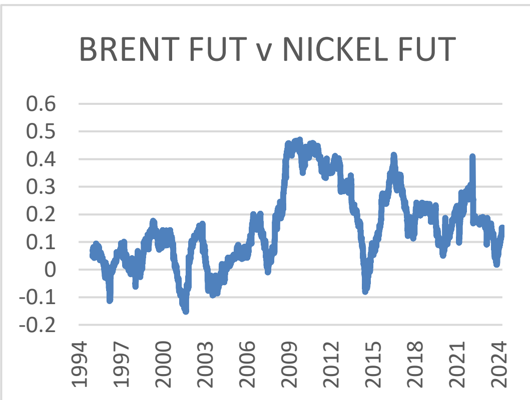
0.2
0
-0.2
-0.4
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024


BRENT FUT v NICKEL FUT
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0.4
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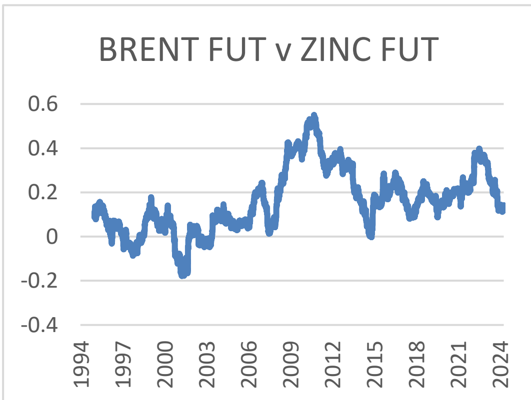
0.1
0
-0.1
-0.2
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024


BRENT FUT v ZINC FUT
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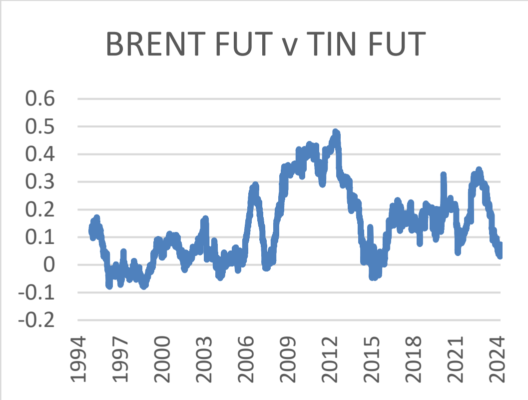
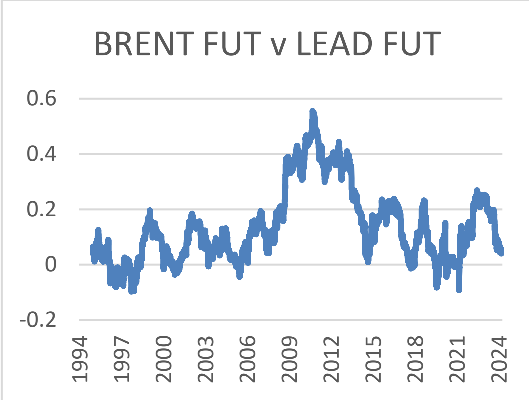
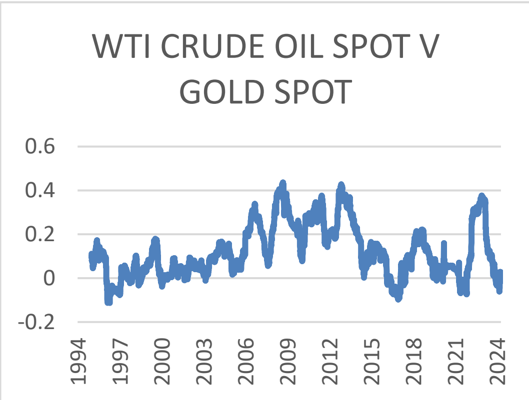
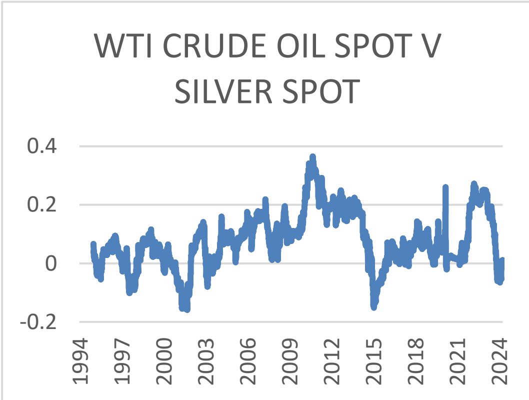
-0.2
-0.4
1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024

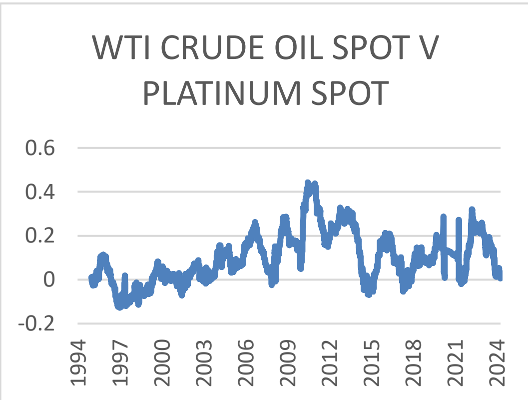


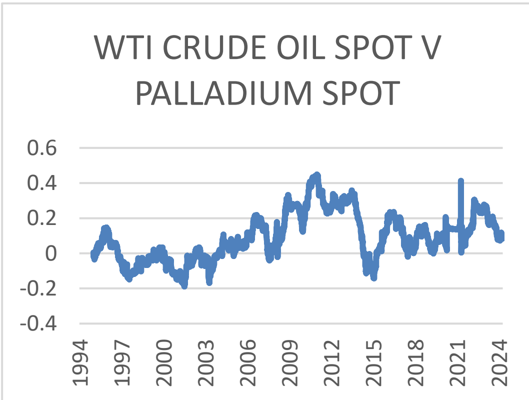


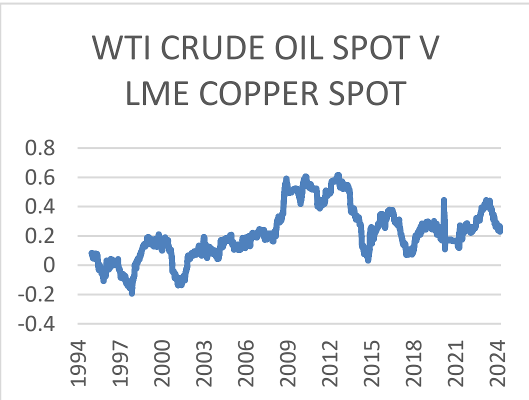
Appendix E: Cross-Sector Pairwise Rolling Return Correlation of Spot Prices

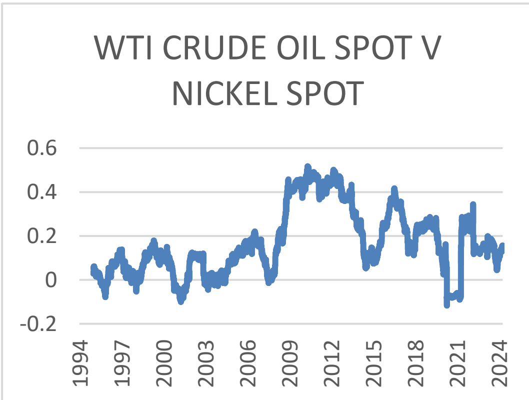


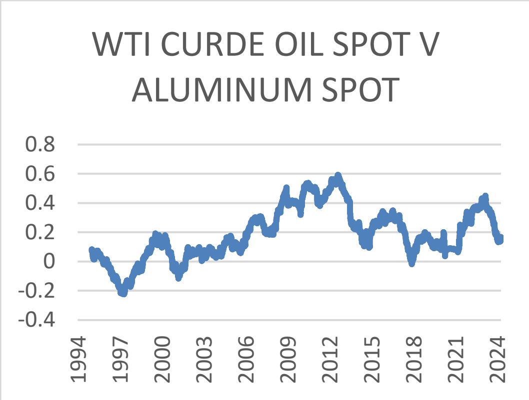


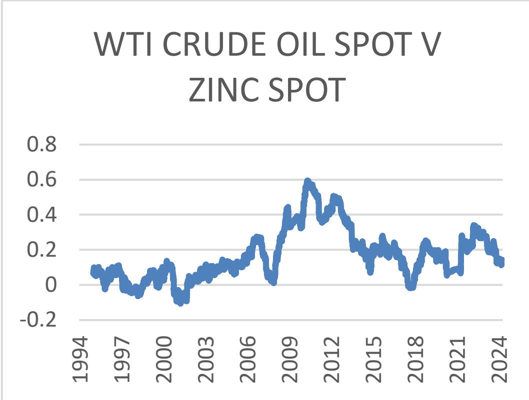









WTI CURDE OIL SPOT V ALUMINUM SPOT
0.8
0.6
0.4
0.2
0
-0.2
-0.4
1994
1997
2000
2003
2006
2009
2012
2015
2018
2021
2024


WTI CRUDE OIL SPOT V ZINC SPOT
0.8
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0.4
0.2
0
-0.2
1994
1997
2000
2003
2006
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2012
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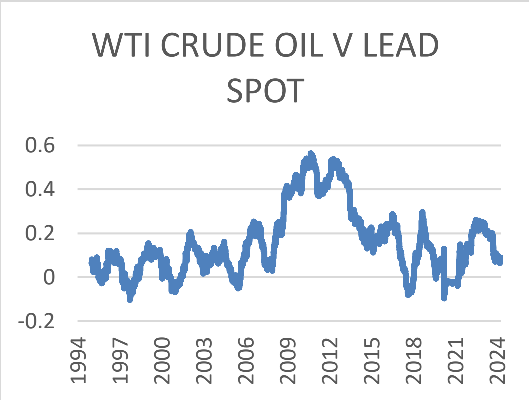
2021
2024


WTI CRUDE OIL V LEAD SPOT
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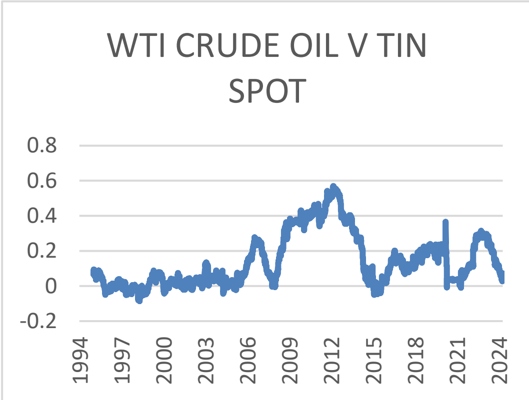
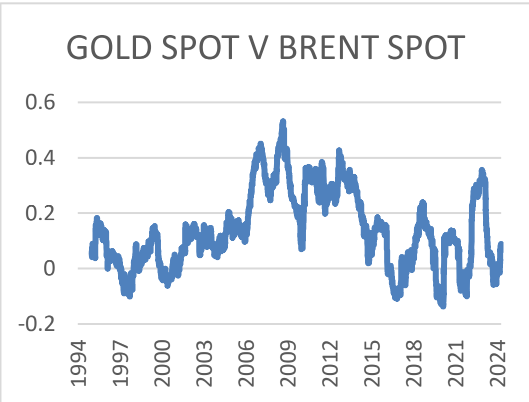
0.2
0
-0.2
1994
1997
2000
2003
2006
2009
2012
2015
2018
2021
2024


WTI CRUDE OIL V TIN SPOT
0.8
0.6
0.4
0.2
0
-0.2
1994
1997
2000
2003
2006
2009
2012
2015
2018
2021
2024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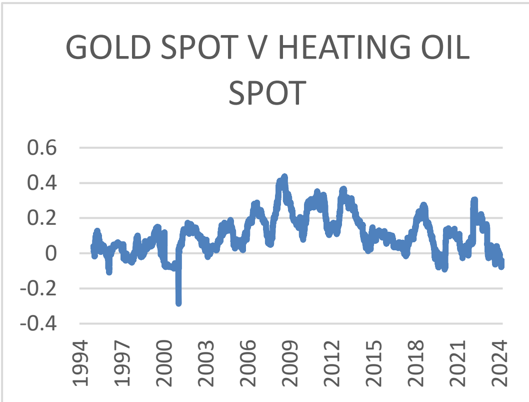
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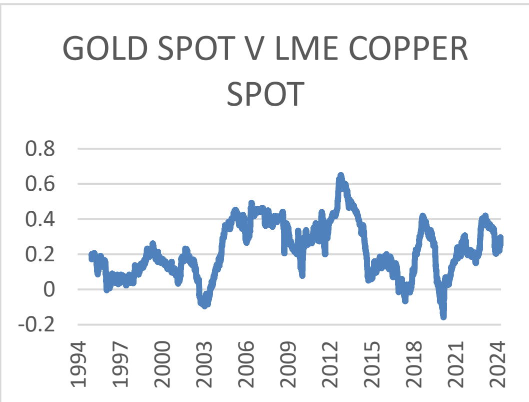
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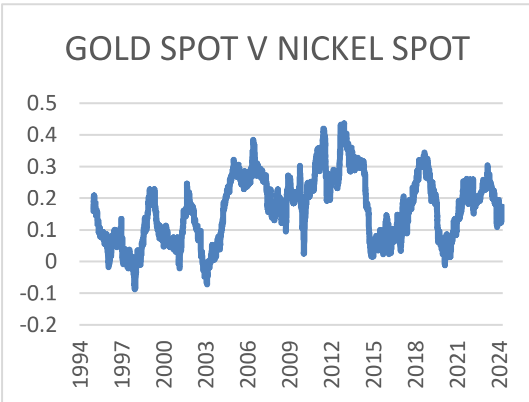
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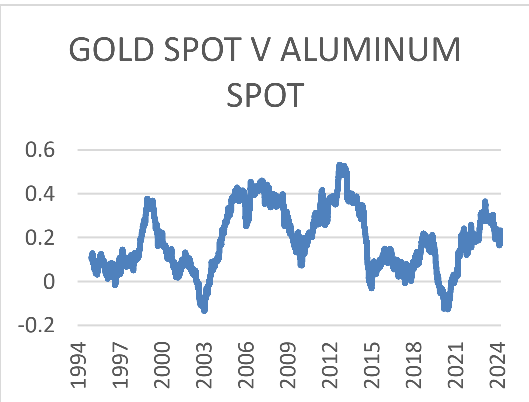
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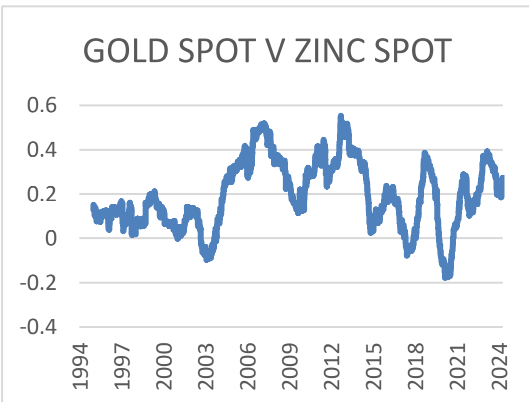
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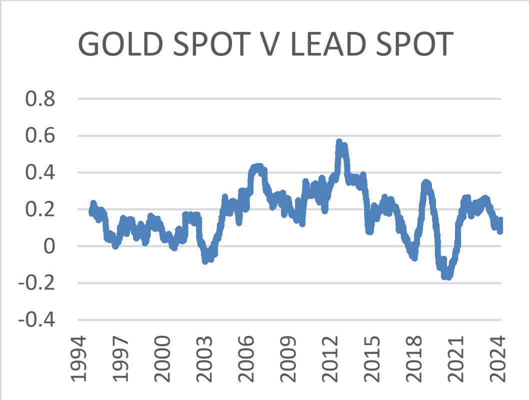
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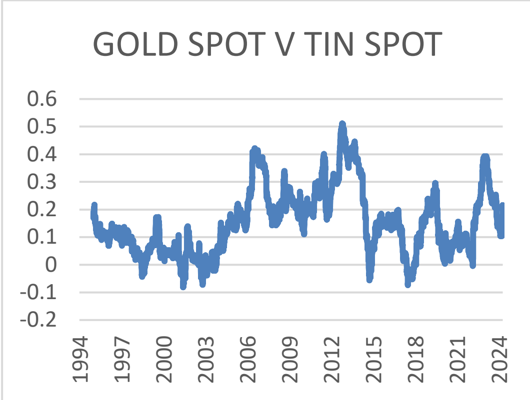
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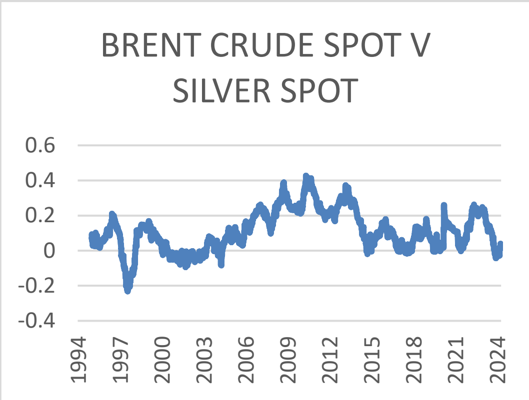
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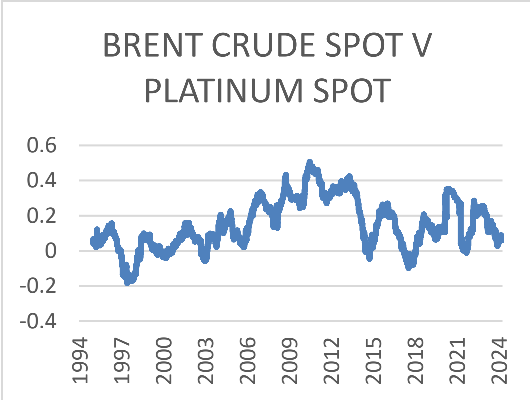
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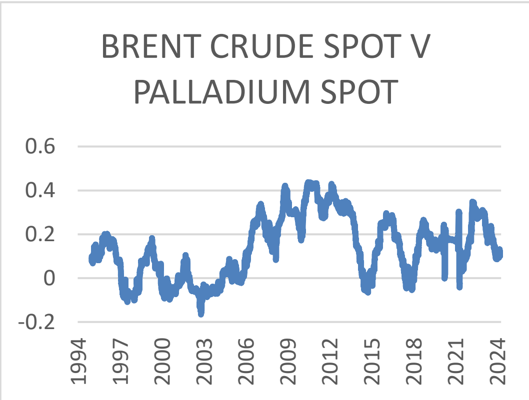
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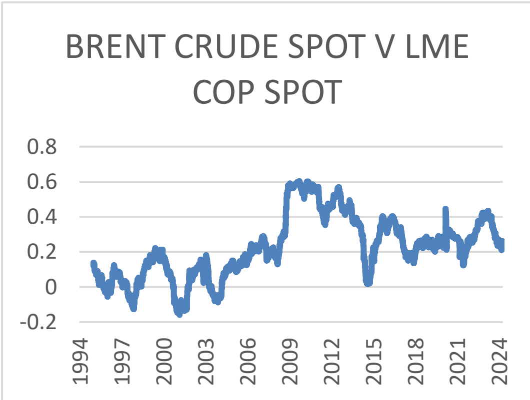
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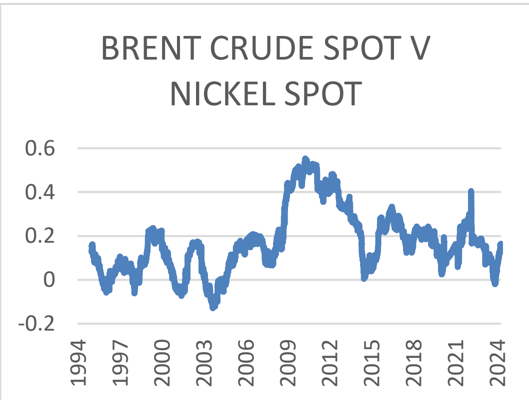
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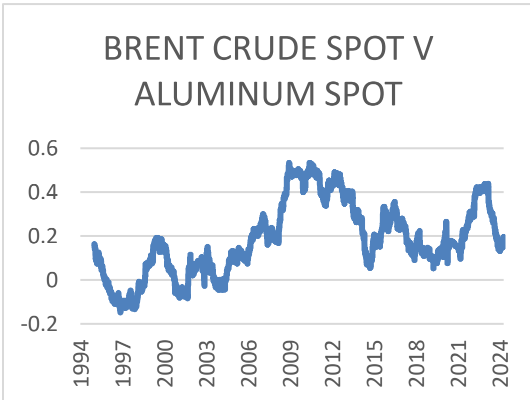
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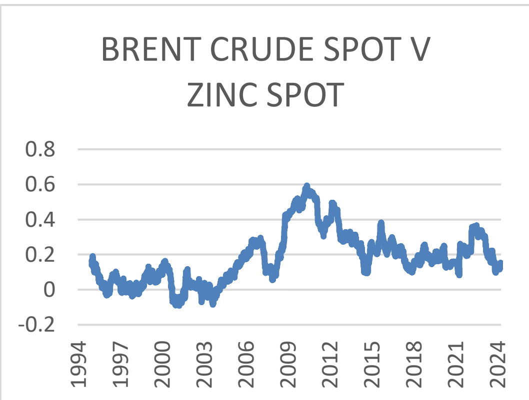
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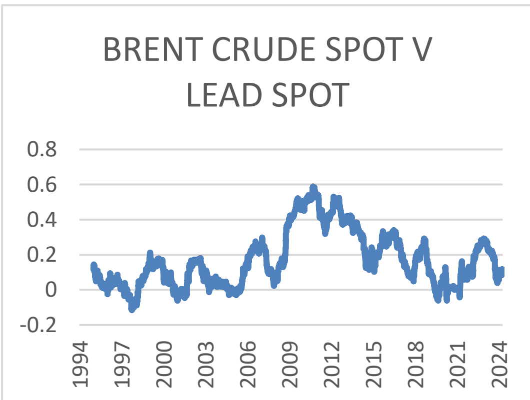
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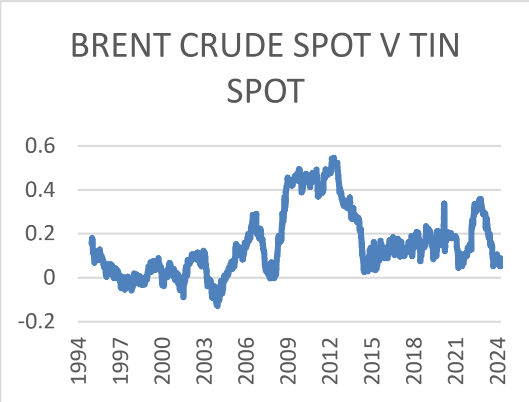
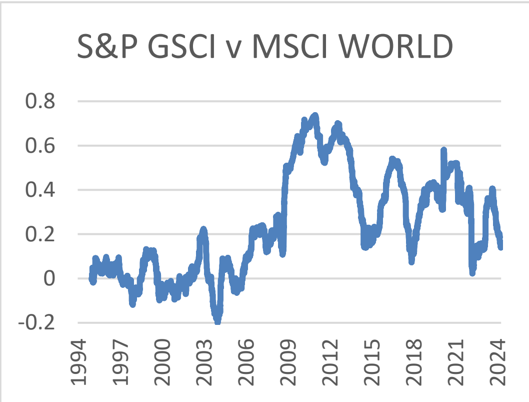
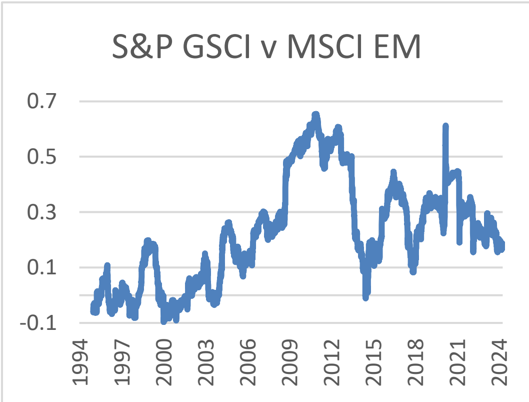
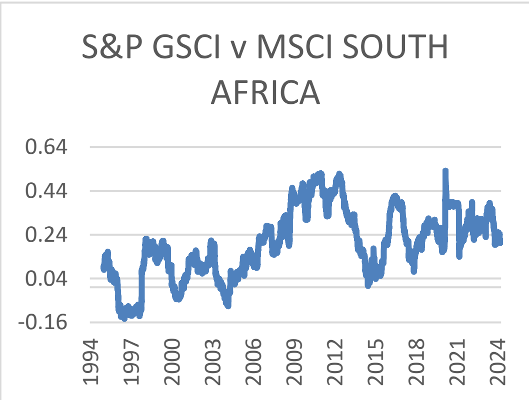
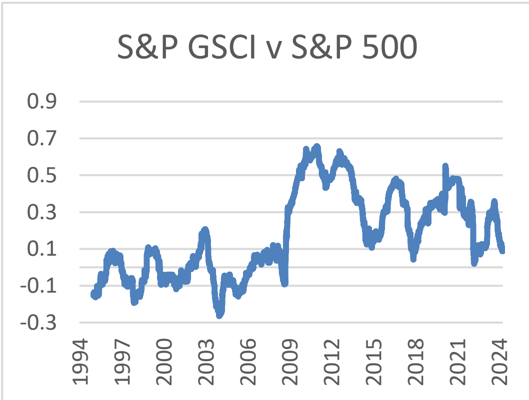


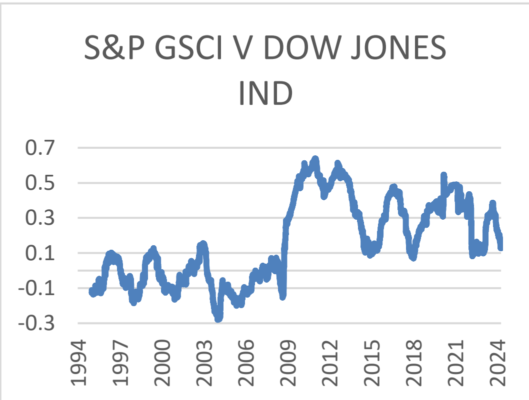
Appendix F: Cross-Sector Pairwise Rolling Return Correlation of Spot Prices

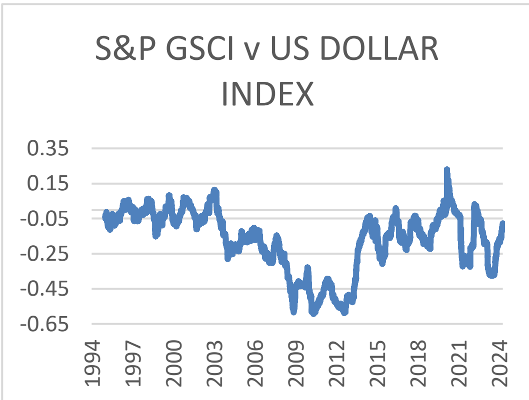


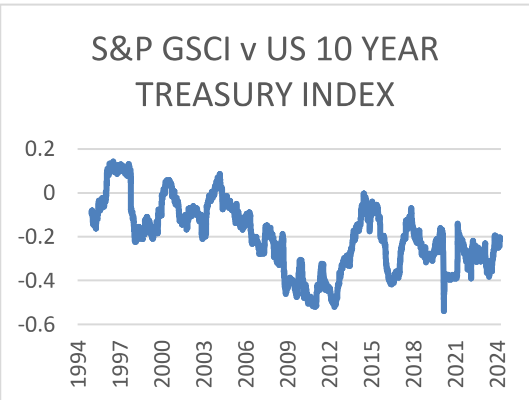












Appendix G: Regression Results with Unstandardised Coefficients

Variable	WTI Crude Spot	Gold Spot	Silver Spot	LME Copper Spot	Aluminium Spot
WTI Crude Futures	0.906*** (0.023)				
Gold Futures		0.632*** (0.040)			
Silver Futures			0.137*** (0.045)		
LME Copper Futures				0.944*** (0.026)	
Aluminium Futures					0.950*** (0.016)
MSCI EM	0.015 (0.026)	0.044*** (0.008)	0.331*** (0.037)	0.076*** (0.015)	0.047*** (0.009)
S&P 500 Composite	-0.018 (0.035)	-0.031*** (0.012)	-0.164*** (0.034)	0.015 (0.011)	0.008 (0.006)
US 10 Year Bond Index	0.031 (0.021)	-0.017 (0.019)	-0.074* (0.042)	-0.051** (0.022)	-0.043** (0.015)
US Dollar Index	-0.023 (0.026)	-0.038* (0.020)	-0.059 (0.055)	-0.097*** (0.026)	-0.089*** (0.020)
FIN Dummy = 1 2000-2024, zero otherwise	-0.005 (0.005)	0.009 (0.007)	-0.005 (0.030)	0.002 (0.007)	-0.0009 (0.005)
Futures returns*FIN dummy	0.064*** (0.022)	0.172*** (0.045)	0.275*** (0.054)	-0.076** (0.032)	-0.093*** (0.022)
GFC Dummy = 1 2007-2008, zero otherwise	-0.0003 (0.015)	0.006 (0.008)	0.006 (0.063)	0.001 (0.016)	-0.0009 (0.012)
Futures returns*GFC dummy	-0.050** (0.077)	-0.083** (0.028)	-0.181 (0.087)	-0.015 (0.024)	-0.008 (0.027)
CV19 Dummy = 1 2020-2021, zero otherwise	0.011 (0.009)	0.003 (0.009)	0.020 (0.053)	0.0004 (0.006)	0.002 (0.008)
Futures returns*CV19 dummy	0.045** (0.034)	0.034 (0.049)	0.021* (0.062)	0.080*** (0.020)	0.125*** (0.017)
Constant	0.006 (0.005)	-0.004 (0.007)	0.016 (0.026)	-0.001 (0.007)	0.001 (0.004)
Observations	7901	7903	7903	7903	7903
R^2	0.832	0.639	0.168	0.821	0.825
F-stat	3550.687 [0.000]	1268.746 [0.000]	145.073 [0.000]	3283.69 [0.000]	3372.55 [0.000]
Wald_F-stat	2415.519 [0.000]	525.416 [0.000]	40.747 [0.000]	1781.11 [0.000]	2664.29 [0.000]
DW	2.372	2.855	2.617	2.572	2.538